Appendix A.
Biophysical Setting and Park Descriptions

Biophysical Setting

Structural Geology and Topography

All but three NCPN units are within the Colorado Plateau Physiographic Province. TICA is located in the Middle Rocky Mountains Province, FOBU in the Wyoming Basin Province, and GOSP in the Basin and Range Province (Hunt 1974). Like the Colorado Plateau, larger units of the NCPN are characterized by striking structural geology—extensive areas of nearly horizontal sedimentary formations possessing diverse physical and chemical characteristics, great upwarps that form dramatic topographic and geomorphic features, and numerous basalt-capped mesas and plateaus. If there is a single theme that unifies the Colorado Plateau as a region, it is structural geology. Ecological patterns and processes are profoundly shaped by widespread exposures of geologic strata that repeat themselves across the Plateau (Table 1). Of the NCPN units DINO, CARE, and ARCH are the most diverse geologically. Many sedimentary strata are common to ARCH, CANY, CARE, COLM, DINO, and ZION.

Elevation, topographic relief, and topographic variability are additional factors that strongly influence patterns of life in NCPN units. Across the entire network, elevation ranges from 1112 m in ZION at the edge of the Mojave Desert, to 3247 m at CEBR (Table 2, Fig. 1). Vertical relief varies from 64 m at PISP to over 1500 m at ZION and CARE. Almost 50 percent of the network is lower than 1750 m (5740 ft)—a consequence of large expanses of low-elevation lands at CANY, CARE, ARCH, and ZION. Relatively high-elevation parks include CEBR, BRCA, BLCA, and CURE. The extreme topographic variability evident in these figures is associated with deeply incised drainage systems, massive vertical escarpments, and abruptly discontinuous environmental gradients that present significant challenges to design and implementation of field-based monitoring.

Climate

Climatic characteristics vary considerably among NCPN units. Based on long-term data collected by National Weather Service Cooperative Network stations at or near NCPN units, mean annual temperatures range from 1.9 °C near CEBR to 16.2 °C at ZION (Table 3). Mean annual precipitation at long-term stations ranges from 192 mm at CARE to 752 mm near CEBR. Spatial estimates of average annual precipitation from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) (http://www.ocs.orst.edu/prism/) provide a more-detailed representation of annual precipitation patterns across the network (Table 4). On the basis of model estimates, over 65 percent of network land area averages less than 300 mm of precipitation annually—emphasizing that aridity is a dominant feature the network.

The seasonal timing of precipitation in relation to evaporative demand is a key climatic characteristic affecting ecosystem structure and function (Walter 1979). The Colorado Plateau is divided roughly into two climatic regions by a broad, northeastward-trending boundary which extends diagonally from northwestern Arizona to northcentral Colorado (Mitchell 1976, Peterson 1994) (Fig. 2). This broad boundary coincides with the mean

northwestern extent of summer precipitation associated with monsoonal circulation patterns carrying moisture from the Gulf of Mexico and the Gulf of California. Approximately two-thirds of the Plateau lies southeast of this climatic boundary and is characterized by a bimodal precipitation regime with both winter and summer maxima. The magnitude of the summer precipitation maximum generally weakens from southeast to northwest, and the northwestern one-third of the Plateau is dominated by winter precipitation.

Precipitation seasonality across the NCPN tends to vary in relation to the monsoon boundary that crosses the network area's southeastern corner. Fig. 3 illustrates climate diagrams for NCPN parks. The four parks located farthest from the monsoon boundary (DINO, TICA, GOSP, and FOBU) show a late-summer dip in average monthly precipitation. Diagrams for other NCPN parks show relatively distinct peaks in average monthly precipitation attributable to monsoon moisture. In these parks, the strength of the summer monsoon signal generally increases with elevation. Although these parks are influenced by summer monsoon precipitation, there is considerable year-to-year variability in amount of monsoon precipitation received due to their location at the circulation pattern's periphery. In association with global temperature changes over the next century, general circulation models predict changes in seasonal precipitation patterns across much of North America (Weltzin and McPherson2003). Ehleringer and colleagues (Ehleringer et al. 2000, Williams and Ehleringer 2000) have hypothesized that effects of global change on precipitation patterns and associated ecological processes may be seen relatively early on the Colorado Plateau due to its proximity to the monsoon boundary.

Table 1. Geologic units exposed in Northern Colorado Plateau Network Parks and monuments.

Age	Formation / deposit	ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR	PISP	TICA	ZION
Quaternary	Aeolian / alluvial deposits	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Basalt / volcanics																■
Tertiary	Basalt / volcanics		■			■			■								
	Browns Park Fm.									■							
	Bishop Cg.									■							
	Markagunt Megabreccia						■										
	Leach Canyon Fm.						■										
	Isom Fm.						■										
	Flagstaff Ls.					■											
	Conglomerate of Boat Mesa			■													
	Brian Head Fm.						■										
	Green River Fm.										■						
	Wasatch Fm.										■						
	Claron Fm.			■			■										
Cretaceous	Kaiparowits Fm.																
	Wahweap Fm.			■			■										
	Straight Cliffs Fm.			■			■										
	Mesaverde Fm.					■											
	Mancos/Tropic Sh.	■	■	■		■		■	■	■							
	Frontier Ss.									■							
	Mowry Sh.									■							
	Dakota Ss.	■	■	■		■		■	■				■				
	Cedar Mt. Fm.	■				■		■	Burro Canyon	Burro Canyon			Burro Canyon				
Jurassic	Morrison Fm.	■	■			■		■	■				■				
	Summerville Fm.	■				■		■	■	Wanakah							
	Curtis Fm.	■				■				Stump							
	Entrada Ss.	■	■			■		■									
	Carmel Fm.	■				■				■							■
	Temple Cap Fm.																■
	Page Ss.					■											
	Navajo Ss.	■			■	■				Glen Canyon							■
	Kayenta Fm.	■			■	■		■									■
	Moenave Fm.														■		■
	Wingate Ss.	■			■	■		■									
Triassic	Chinle Fm.	■			■	■		■		■					■		■
	Moenkopi Fm.	■			■	■				■				■	■		■
Permian	Kaibab Ls.					■											■
	Toroweap Fm.																■
	Cutler Gp.	■			■	■								Cedar Mesa			
	Elephant Canyon Fm.				■												
	Park City Fm.									■							
Pennsylvanian	Oquirrh Fm.											■					
	Honaker Trail Fm.	■			■												
	Paradox Fm.	■			■												
	Weber Ss.									■							
	Morgan Fm.									■							
	Round Valley Ls.									■							
Mississipian	Doughnut Sh. / Humbug Fm.									■							
	Deseret Ls.															■	
	Madison Ls.									■							
Cambrian	Misc. igneous and metamorphics		■							■						■	
	Lodore Fm.									■							
Pre-Cambrian	Uinta Mt. Gp.									■							
	Misc. igneous and metamorphics		■					■								■	

Table 2. Elevation and topographic characteristics of Northern Colorado Plateau Network Parks and Monuments. Total hectares per management unit may vary slightly from those presented elsewhere in the document due to cumulative areal discrepancies in digital coverages.

Park	Elevation (m)		Relief	Hectares by elevation zone (m) (values in parentheses indicate percent of total area)									Total	Slope (deg.)	
code	min	max	(m)	1000-1250	1250-1500	1500-1750	1750-2000	2000-2250	2250-2500	2500-2750	2750-3000	3000-3250	(ha)	Mean	s.d.
ARCH	1,206	1,725	519	389 (1.3)	20,424 (65.9)	10,160 (32.8)							30,974 (100.0)	9.8	11.5
BLCA	1,636	2,752	1,116			270 (2.4)	1,360 (11.9)	2,567 (22.4)	5,180 (45.3)	2,059 (18.0)	2 (<0.1)		11,439 (100.0)	21.8	17.0
BRCA	2,000	2,777	777					3,926 (26.9)	7,367 (50.4)	3,297 (22.6)	23 (0.2)		14,613 (100.0)	17.5	12.3
CANY	1,140	2,189	1,049	9,725 (7.2)	49,730 (36.8)	58,256 (43.1)	16,802 (12.4)	689 (0.5)					135,201 (100.0)	17.6	16.1
CARE	1,182	2,730	1,548	227 (0.2)	4,112 (4.2)	23,717 (24.0)	47,585 (48.2)	20,958 (21.2)	1,867 (1.9)	183 (0.2)			98,650 (100.0)	18.1	14.7
CEBR	2,461	3,247	785						20 (0.8)	673 (27.1)	873 (35.2)	914 (36.9)	2,480 (100.0)	24.8	13.8
COLM	1,411	2,160	749		348 (4.2)	2,577 (31.2)	4,077 (49.4)	1,252 (15.2)					8,255 (100.0)	16.8	13.9
CURE	1,982	2,898	916				34 (0.2)	1,736 (10.5)	12,933 (77.9)	1,801 (10.8)	108 (0.6)		16,612 (100.0)	16.7	15.2
DINO	1,442	2,747	1,305		1,893 (2.2)	21,625 (24.8)	27,460 (31.5)	24,359 (27.9)	10,909 (12.5)	1,062 (1.2)			87,308 (100.0)	17.6	13.8
FOBU	2,012	2,466	454					2,189 (65.3)	1,164 (34.7)				3,353 (100.0)	10.5	6.9
GOSP	1,317	1,613	296		1,013 (94.2)	63 (5.8)							1,075 (100.0)	6.3	5.2
HOVE	1,548	2,056	508			262 (80.5)	6 (1.7)	58 (17.6)					326 (99.9)	6.4	6.3
NABR	1,702	2,019	318			67 (2.3)	2,862 (95.6)	63 (2.1)					2,993 (100.0)	12.6	13.0
PISP	1,495	1,559	64		2 (14.6)	14 (85.4)							16 (100.0)	6.1	6.8
TICA	1,669	2,452	783			23 (23.6)	38 (38.7)	25 (25.7)	12 (12.0)				98 (100.0)	37.8	12.9
ZION	1,112	2,661	1,549	1,239 (2.1)	8,857 (14.8)	12,232 (20.5)	21,852 (36.5)	12,081 (20.2)	3,408 (5.7)	144 (0.2)			59,813 (100.0)	26.3	18.4
Network	**1,112**	**3,247**	**2,134**	**11,589** (2.4)	**86,601** (18.2)	**129,625** (27.3)	**122,366** (25.8)	**70,139** (14.8)	**43,096** (9.1)	**9,299** (2.0)	**1,042** (0.2)	**951** (0.2)	**474,709** (100.0)		

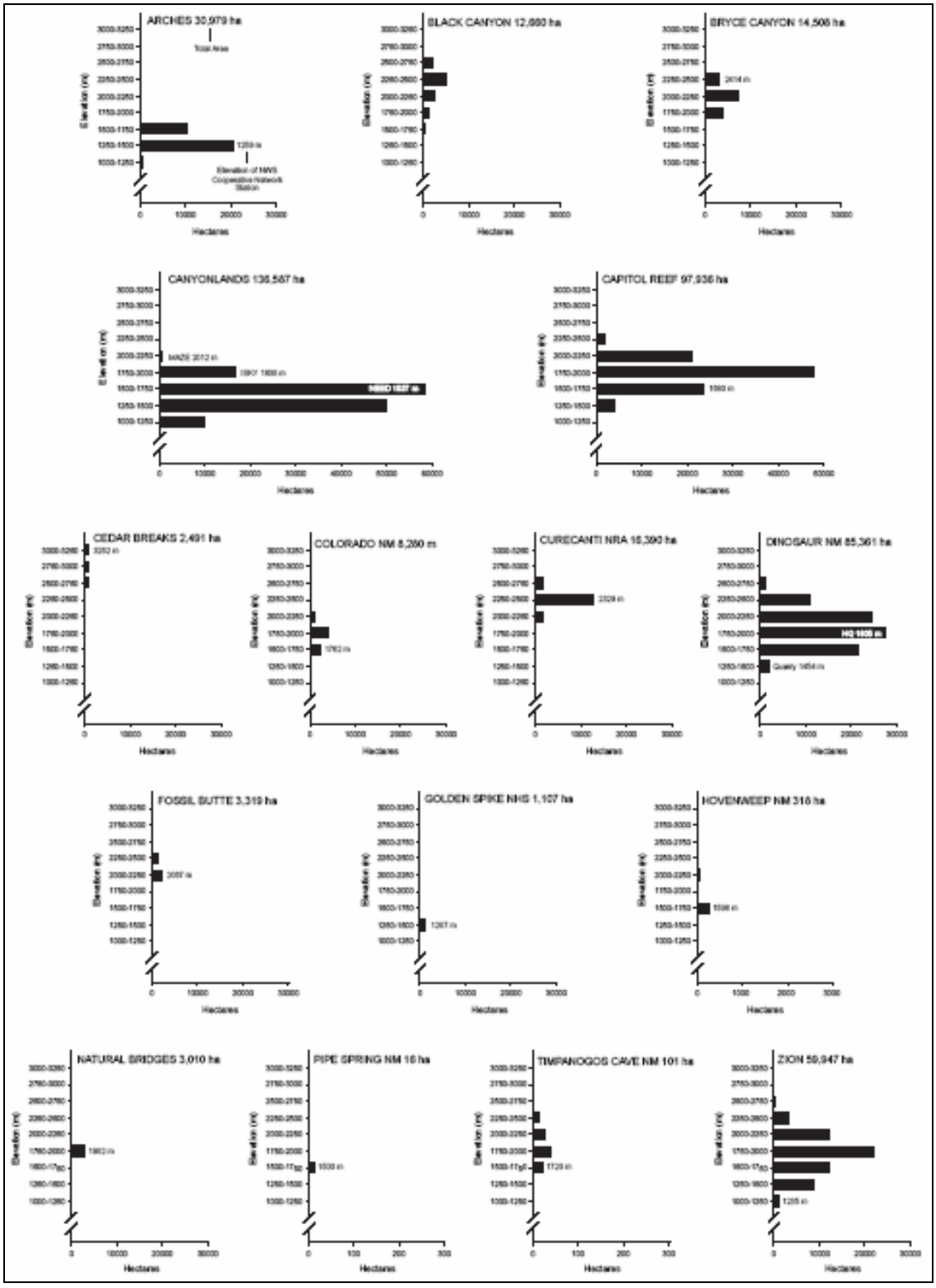


Figure 1. Elevation profiles of Northern Colorado Plateau Network parks. Note different x-axis scales for Hovenweep, Pipe Spring, and Timpanogos Cave National Monuments. Elevations of National Weather Service Cooperative Network Climate Stations are indicated for each park.

Table 3. Selected climate data for National Weather Service (NWS) Cooperative Network stations at or near Northern Colorado Plateau Network Parks and Monuments. Values are averages based on data obtained from the Western Regional Climate Center (http://www.wrcc.dri.edu/climsum.html). Seasons are defined ecologically following Comstock and Ehleringer (1992).

							Total precipitation							Mean temperature			
Park / District	NWS Station Name	Elevation (m)	Latitude (dd mm N)	Longitude (dd mm W)	Period of Record	Years of Record	Annual (mm)	Oct-Feb (mm)	Oct-Feb (%)	Mar-May (mm)	Mar-May (%)	Jun-Sep (mm)	Jun-Sep (%)	Annual (˚C)	Oct-Feb (˚C)	Mar-May (˚C)	Jun-Sep (˚C)
ARCH	Arches NP	1259	38 37	109 37	5/80 - present	22	227	88	39	62	27	77	34	14.0	4.9	13.9	25.5
BRCA	Bryce Canyon NP	2412	37 39	112 10	6/59 - present	43	406	166	41	87	21	153	38	5.2	-1.6	3.8	14.6
CANY / ISKY	Canyonlands - The Neck	1808	38 27	109 49	6/65 - present	37	231	89	38	61	26	81	35	11.5	3.0	10.7	22.7
CANY / MAZE	Canyonlands - Hans Flat*	2012	38 15	110 10	10/80 - present	22	251	95	38	57	23	99	40	10.7	2.8	9.7	21.4
CANY / NEED	Canyonlands - The Needle	1537	38 09	109 45	6/65 - present	37	215	83	39	53	25	79	37	11.8	3.1	11.5	23.0
CARE	Capitol Reef NP	1680	38 17	111 16	4/67 - present	35	192	61	32	45	23	87	45	12.1	3.8	11.7	22.9
CEBR	Blowhard Mtn.*	3262	37 35	112 51	6/64 - present	38	752	331	44	228	30	194	26	1.9	-3.6	-0.6	10.7
COLM	Colorado NM	1762	39 06	108 44	8/48 - present	54	283	111	39	76	27	96	34	11.1	2.5	10.3	22.3
CURE	Blue Mesa Lake	2329	38 28	107 10	9/67 - present	35	243	100	41	39	16	104	43	4.8	-3.8	4.5	15.9
DINO / HQ	Dinosaur NM	1805	40 14	108 58	6/65 - present	37	302	106	35	88	29	107	35	8.4	-0.6	8.0	19.9
DINO / QUAR	Dinosaur NM Quarry Area	1454	40 26	109 18	4/58 - present	44	219	86	39	60	27	73	33	8.8	-1.2	9.3	20.9
FOBU	Fossil Butte	2067	41 50	110 46	8/90 - present	12	281	110	39	75	27	96	34	3.9	-4.1	3.4	14.3
GOSP	Corinne*	1287	41 33	112 07	7/48 - present	54	388	177	46	124	32	87	23	9.5	1.1	8.9	20.3
HOVE	Hovenweep NM	1598	37 23	109 05	12/55 - present	47	285	134	47	66	23	84	30	10.9	2.6	10.2	21.7
NABR	Natural Bridges NM	1982	37 37	109 59	6/65 - present	37	319	132	41	69	22	118	37	10.3	2.6	9.1	20.8
PISP	Pipe Spring NM	1500	36 52	112 44	6/63 - present	39	278	125	45	62	22	91	33	12.6	5.5	11.5	22.3
TICA	Timpanogos Cave	1720	40 27	111 42	7/48 - present	54	634	284	45	204	32	147	23	9.6	1.5	8.5	20.3
ZION	Zion NP	1235	37 13	112 59	7/48 - present	54	380	179	47	98	26	104	27	16.2	8.9	14.8	26.5

*station not in park

Table 4. Distribution of Northern Colorado Plateau Network Park and Monument lands among average annual precipitation zones estimated by the PRISM model (http://www.ocs.orst.edu/prism/). Total hectares per management unit may vary slightly from those presented elsewhere in the document due to cumulative areal discrepancies in digital coverages.

Park code	Hectares by precipitation zone (mm) (values in parentheses indicate percent of total area)																	Total (ha)
	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950-1000	
ARCH		30,090 (97.2)	878 (2.8)															30,968 (100.0)
BLCA				710 (5.9)	3,811 (31.8)	3,944 (32.9)	3,517 (29.4)											11,982 (100.0)
BRCA				4,193 (28.7)	6,890 (47.1)	3,535 (24.2)												14,619 (100.0)
CANY	18,389 (13.6)	96,552 (71.5)	16,558 (12.3)	3,461 (2.6)	39 (0.0)													134,999 (100.0)
CARE	48,140 (48.9)	44,886 (45.6)	4,598 (4.7)	507 (0.5)	252 (0.3)	158 (0.2)	0 (0.0)											98,542 (100.0)
CEBR												256 (10.4)	586 (23.8)	797 (32.3)	522 (21.1)	306 (12.4)	1 (0.0)	2,469 (100.0)
COLM		174 (2.1)	3,286 (39.7)	3,708 (44.8)	1,102 (13.3)													8,270 (100.0)
CURE			2,983 (15.0)	4,872 (24.5)	2,607 (13.1)	2,422 (12.2)	5,400 (27.2)	1,145 (5.8)	421 (2.1)									19,850 (100.0)
DINO		17,482 (20.1)	33,150 (38.0)	29,257 (33.6)	7,174 (8.2)	122 (0.1)												87,185 (100.0)
FOBU				582 (17.4)	1,150 (34.3)	788 (23.5)	779 (23.3)	50 (1.5)										3,348 (100.0)
GOSP				238 (22.1)	841 (78.0)													1,079 (100.0)
HOVE			211 (64.6)	58 (17.7)	57 (17.6)													326 (100.0)
NABR				2,993 (100.0)														2,993 (100.0)
PISP			16 (100.0)															16 (100.0)
TICA										1 (0.6)	70 (69.8)	30 (29.5)						100 (100.0)
ZION			2,764 (4.6)	5,557 (9.3)	20,085 (33.6)	27,100 (45.3)	2,752 (4.6)	1,573 (2.6)	19 (0.0)									59,851 (100.0)
NCPN	66,529 (14.0)	189,184 (39.7)	64,445 (13.5)	56,136 (11.8)	44,008 (9.2)	38,070 (8.0)	12,447 (2.6)	2,768 (0.6)	440 (0.1)	1 (0.0)	70 (0.0)	285 (0.1)	586 (0.1)	797 (0.2)	522 (0.1)	306 (0.1)	1 (0.0)	476,596 (100.0)

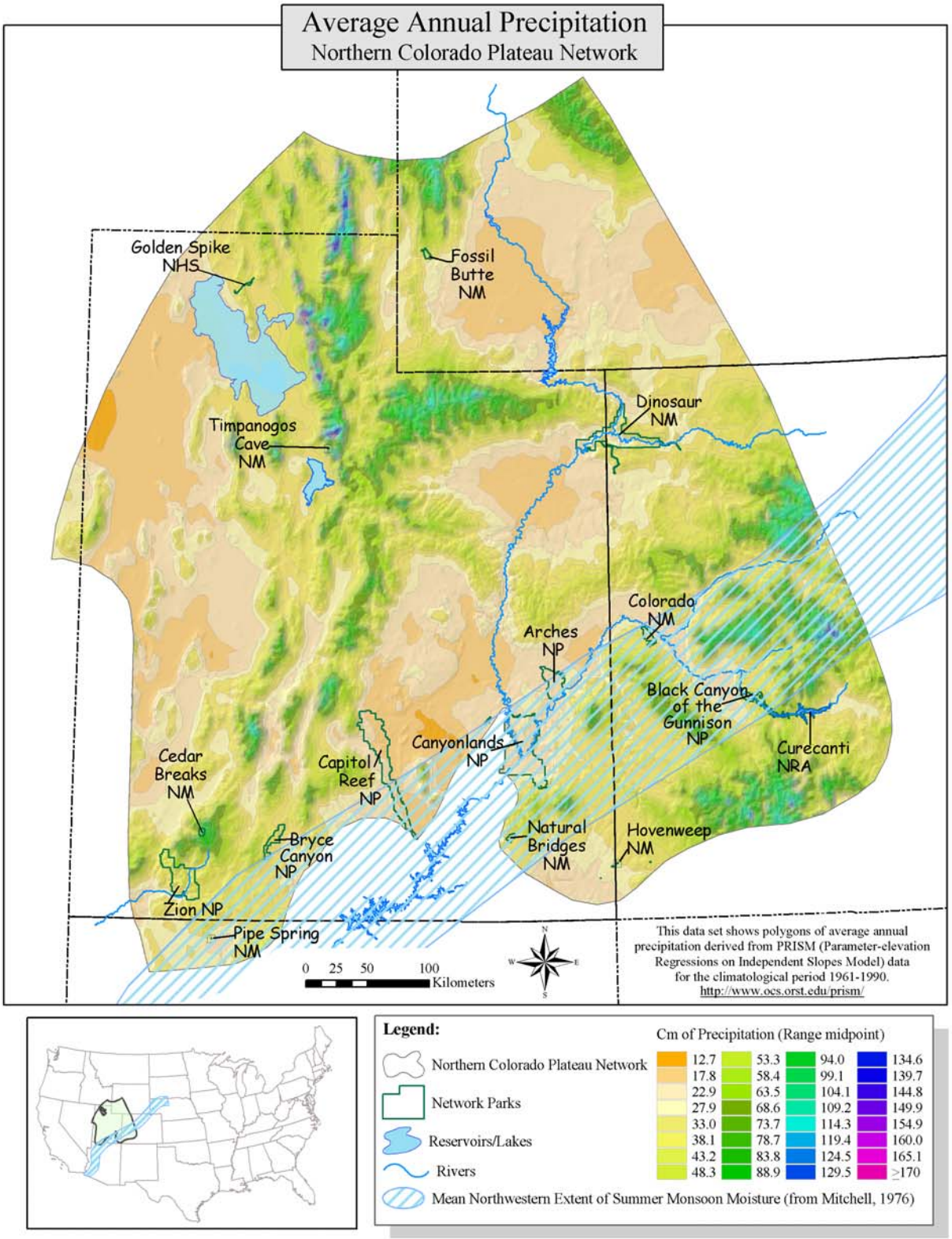


Figure 2. Average annual precipitation, Northern Colorado Plateau Network.

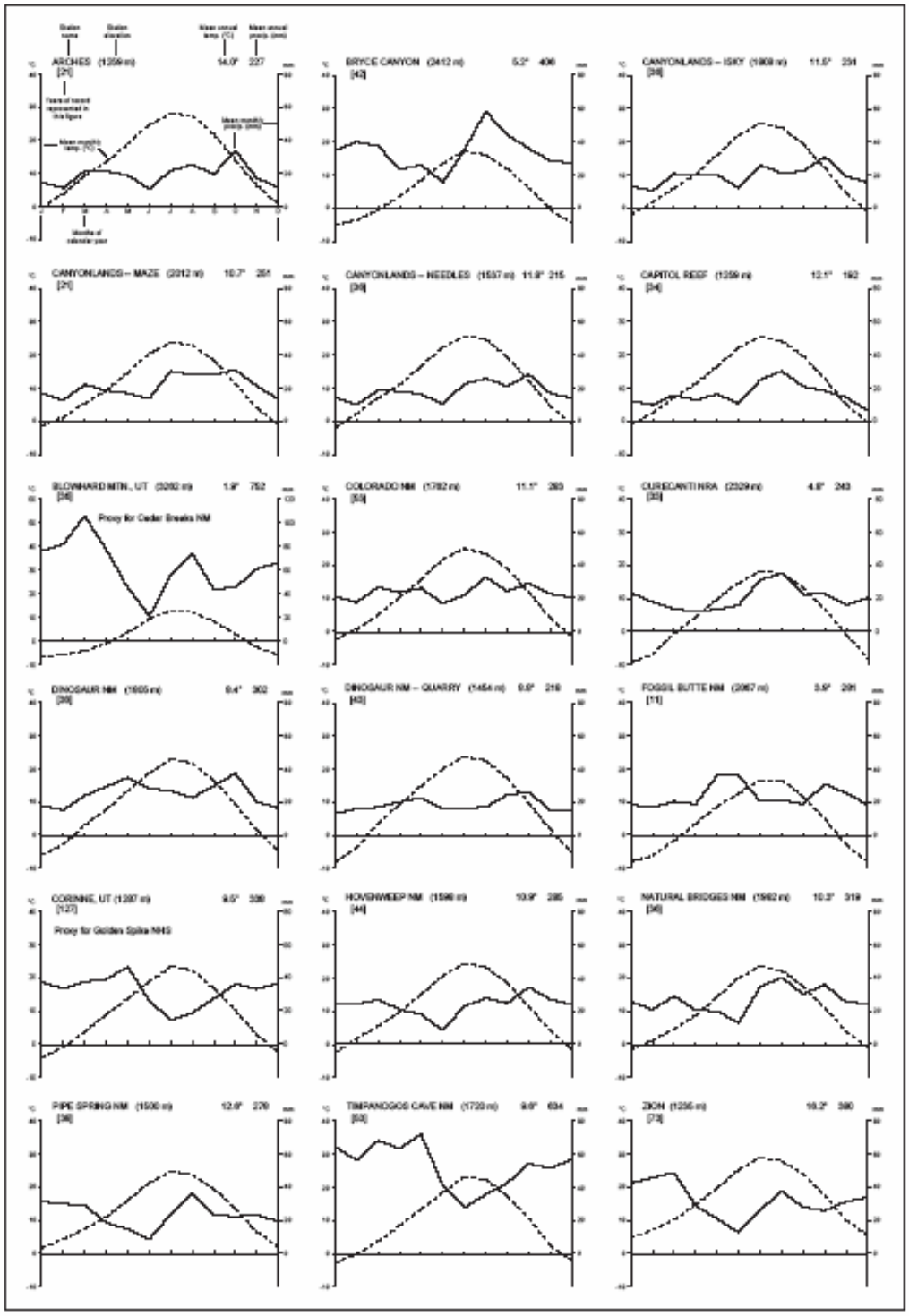


Figure 3. Climate diagrams for Northern Colorado Plateau Network parks. Data were collected at National Weather Service Cooperative Network Stations and acquired from the Western Regional Climate Center (http://www.wrcc.dri.edu/climsum.html).

Ecological Units

Ecoregions

The National Hierarchical Framework of Ecological Units developed by the U.S. Forest Service (ECOMAP 1993, Bailey et al. 1994, McNab and Avers 1994) provides a useful means of integrating factors such as regional physiography and climate to assess broad-scale differences and similarities among NCPN parks. Ecological units within this multi-scale hierarchy also are referred to as "ecoregions" following Bailey (Bailey et al. 1994, Bailey 1995). Units in the hierarchy are designed on the basis of similar 1) potential natural communities, 2) soils, 3) hydrologic function, 4) landforms and topography, 5) lithology, 6) climate, and 7) ecological processes such as nutrient cycling, productivity, and natural disturbance regimes (Cleland et al. 1997). The relative importance of these factors in classification varies in relation to the spatial scale of units.

NCPN parks and monuments are located within five provinces of the national hierarchy (Fig. 4, Table 5). Most NCPN units are included in sections of the semidesert and desert provinces, reflecting the dominance of arid and semiarid conditions in the NCPN. Notably, four of the five prototype parks are located in a single section—the Northern Canyonlands Section of the Intermountain Semidesert & Desert Province. This suggests that some research and protocol development in non-prototype parks may be warranted to fully meet network needs.

Ecosystems

As a consequence of variations in substrate, topography, and climate, NCPN units support a wide range of ecosystems. On the basis of functional similarities, NCPN staff have grouped these into five broad categories, 1) unique ecosystems such as orchards, caves, and mines; 2) sparsely vegetated terrestrial ecosystems; 3) arid-semiarid shrubland, grassland, and woodland ecosystems; 4) montane shrubland, coniferous woodland, and forest ecosystems; and 5) riparian and wetland and aquatic ecosystems (Table 6). The last four of these are described briefly below, emphasizing the dominant vegetation. Plant species nomenclature follows Welsh et al. (1993).

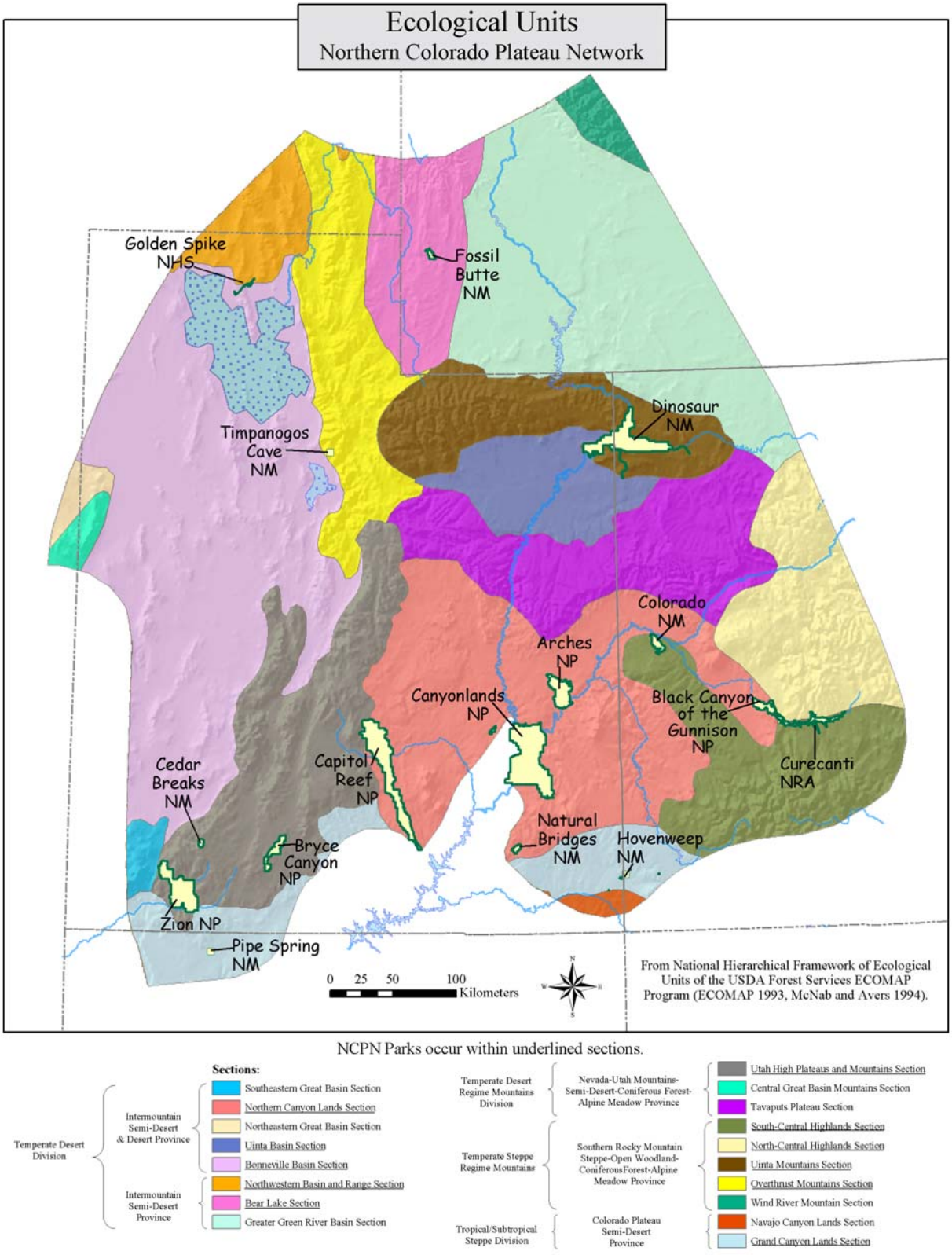


Figure 4. Ecological units of the Northern Colorado Plateau Network.

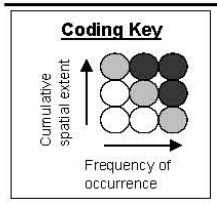
Table 5. Placement of Northern Colorado Plateau Network Parks and Monuments within the national hierarchical framework of ecological units of the USDA Forest Service's ECOMAP program (ECOMAP 1993, McNab and Avers 1994). All divisions listed are located within the Dry Domain.

Division (code) ***Province (code)*** *Section*	ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR	PISP	TICA	ZION
Temperate Desert Division (340)																
Intermountain Semidesert & Desert Province (341)																
Northern Canyonlands Section	X	X		X	X			X					X			
Uinta Basin Section									X							
Bonneville Basin Section											X					
Intermountain Semidesert Province (342)																
Northwestern Basin and Range Section											X					
Bear Lake Section										X						
Tropical / Subtropical Steppe Division (310)																
Colorado Plateau Semidesert Province (313)																
Grand Canyon Lands Section												X		X		
Temperate Steppe Regime Mountains (M330)																
Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province (M331)																
South-Central Highlands Section							X	X								
North-Central Highlands Section		X						X								
Uinta Mountains Section									X							
Overthrust Mountains Section															X	
Temperate Desert Regime Mountains Division (M340)																
Nevada -Utah Mountains - Semidesert - Coniferous Forest - Alpine Meadow Province (M341)																
Utah High Plateaus and Mountains Section			X			X										X

Table 6. Relative occurrence of major terrestrial, riparian, wetland and aquatic ecosystems with NCPN units. See Coding Key (below) for explanation of table entries.

Ecosystem category	NCPN units														
Ecosystems	ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR	PISP	TICA	ZION
Riparian-wetland and aquatic ecosystems (combined)																
Lotic systems																
Rivers with associated aquatic & riparian systems																
Perennial streams with associated aquatic & riparian systems																
Intermittent streams with associated aquatic & riparian systems																
Lentic systems																
Reservoirs																
Perennial wetlands / marshes / wet meadows																
Ephemeral playas / wetlands																
Hanging gardens																
Springs & seeps (other than hanging gardens)																
Slickrock potholes / waterpockets																
Subalpine woodlands																
Spruce-fir forests																
Montane meadows / shrubland parks																
Aspen woodlands / forests																
Douglas-fir woodlands / forests																
Ponderosa pine woodlands / forests																
Montane shrublands																
Pinyon-juniper woodlands / savannas																
Sagebrush shrublands / shrub steppe																
Greasewood shrublands / shrub steppe																
Mixed grasslands / shrub steppe																
Shadscale dwarf-shrublands / shrub steppe																
Blackbrush shrublands / shrub steppe																
Mat saltbush dwarf-shrublands / shrub steppe																
Shale-mudstone-siltstone badlands																
Claron breaks / limestone barrens																
Rock-outcrop / slickrock																
Cultivated orchards																
Caves and mines																

Coding Key



Sparsely Vegetated Terrestrial Ecosystems

These ecosystems are associated with bedrock exposures of shales, mudstones, siltstones, limestones, and sandstones. Vegetation is sparse because of physical and/or chemical traits of the substrate that strongly affect the availability of soil resources (e.g., saline shales and calcareous siltstones and mudstones), substrate stability (e.g., decomposing / eroding Claron limestone), and/or establishment opportunities (e.g., sandstone slickrock). Despite the barren appearance of these ecosystems, they frequently support unique communities consisting of rare and/or endemic plants (see discussion under *Floristic Distinctiveness* below). From a conservation perspective, the significance of these ecosystems greatly exceeds what would be expected on the basis of their productivity or standing biomass. Sparsely vegetated terrestrial ecosystems are extensive in many NCPN units. Such ecosystems are particularly significant both at CEBR and BRCA, where they are associated with the distinctive Claron Breaks.

Arid-Semiarid Shrubland, Grassland, and Woodland Ecosystems

The following descriptions of arid-semiarid ecosystems draw in part from the work of West and Young (2000) and are supplemented by observations and experience of NCPN staff.

-Mat Saltbush Dwarf Shrublands: dominated by perennial dwarf shrubs of the *Chenopodiaceae*, these ecosystems typically are associated with badland topography on shale substrates such as those associated with the Morrison, Mancos, or Tropic formations. *Atriplex corrugata* and *A. gardneri* var. *cuneata* are common dominants. This ecosystem is common but not extensive at CANY and CARE.

-Blackbrush Shrublands: dominated by the shrub *Coleogyne ramosissima*, this type usually is associated with residuum derived from calcareous geologic substrates, soils characterized by a shallow petrocalcic horizon, or with carbonate-stabilized sand dunes. With the exception of occasional *Ephedra* spp., *Gutierrezia* spp., and *Opuntia* spp., other woody plants are uncommon in blackbrush shrublands. Common herbaceous species include the grasses *Hilaria jamesii*, *Stipa hymenoides*, and *Sporobolus* spp. Relative dominance generally shifts from blackbrush to perennial grasses along a gradient of increasing depth to the petrocalcic horizon or the underlying geologic substrate. Although blackbrush shrublands occur throughout much of the Colorado Plateau and Mojave Desert regions, the spatial extent of this ecosystem is greatest in southeastern Utah. Blackbrush ecosystems are extensive landscape dominants at ARCH and CANY.

-Shadscale Dwarf Shrublands: dominated by the perennial dwarf shrub *Atriplex confertifolia*, this type tends to occur on shallow calcareous soils with higher clay and salt content than soils that support blackbrush. Perennial grasses such as *Sporobolus airoides*, *H. jamesii*, and *Stipa hymenoides* may co-dominate the vascular vegetation, depending on disturbance history. Shadscale-dominated ecosystems are most common at CANY, CARE, ARCH, and DINO.

-Mixed Grasslands / Shrub Steppe: in the Northern Canyonlands Section (Table 5), this type occurs on relatively deep, undeveloped sandy soils and is dominated by perennial

grasses such as *Stipa comata*, *S. hymenoides*, *Hilaria jamesii*, *Bouteloua gracilis*, and *Aristida purpurea*. The dwarf-shrub *Gutierrezia* and the chenopod shrubs *Atriplex canescens* and *Ceratoides lanata* also are common. At higher elevations and latitudes, grasses such as *Elymus smithii*, *E. spicatus*, *E. lanceolatus*, *Festuca idahoensis*, and *Stipa thurberiana* increase in importance. To varying degrees, all shrubland ecosystems in NCPN units tend to intergrade with grassland vegetation in relation to disturbance history and soil characteristics. Grassland ecosystems are most common at DINO, CARE, CANY (Kleiner and Harper 1972, 1977), ARCH, and ZION. Nationwide, grasslands are among the most critically endangered ecosystem types because of cumulative losses to land-use activities (Noss et al. 1995). For this reason, healthy grassland ecosystems are among the most significant natural resources of NCPN units.

-Greasewood Shrublands: dominated by the perennial shrub *Sarcobatus vermiculatus*, this ecosystem typically is associated with saline basins and riparian terraces—frequently in association with a relatively high ground water table. Shrubs such as *Artemisia tridentata* var. *tridentata*, *Chrysothamnus nauseousus*, and *Suaeda* spp. may co-dominate. Typical herbaceous components include grasses *Distichlis* spp., *Sporobolus airoides*, *Elymus cinereus*, and forbs (both exotic) *Halogeton glomeratus* and *Salsola* spp. Greasewood ecosystems occur in most NCPN units, but they typically are minor landscape elements except at CARE and DINO.
-Sagebrush Shrublands: dominated by varieties of *Artemisia tridentata*. West and Young (2000) differentiated sagebrush ecosystems into major two types:
1) Great Basin sagebrush, found throughout all but the northernmost portions of the Colorado Plateau and NCPN; and
2) Sagebrush steppe, found at higher latitudes and elevations than Great Basin sagebrush. In the former, sagebrush typically accounts for greater than 70 percent of live vascular plant cover, with *Chrysothamnus* spp. and *Elymus elymoides* as the most common co-occurring shrubs and grasses, respectively. As suggested by the name, the comparatively mesic sagebrush steppe usually is co-dominated by perennial grasses such as *Elymus smithii*, *E. spicatus*, *E. lanceolatus*, *Festuca idahoensis*, and *Stipa thurberiana*. These two major sagebrush types can be viewed as contrasting endpoints of a structural continuum that varies along gradients of effective soil moisture and disturbance history. Sagebrush ecosystems are particularly important landscape components at DINO, CURE, HOVE, FOBU, and BLCA. Sagebrush-dominated ecosystems of the Intermountain West have been severely impacted by land-use activities. Good-condition representatives of this ecosystem type are scarce and considered critically imperiled on a regionwide basis (Noss et al. 1995). For this reason, healthy sagebrush ecosystems are among the most significant natural resources of NCPN units.

-Pinyon-Juniper Woodlands: coniferous woodlands dominated by various species of pinyon and juniper are widespread across the Colorado Plateau (West and Young 2000, McPherson 1997). *Juniperus osteosperma* and *Pinus edulis* are the dominant taxa in NCPN units, although *P. monophylla* also occurs at ZION. Both juniper and pinyon are substrate generalists capable of establishing in rocky soils derived from a wide range of geologic parent materials (Harper and Davis 1999, West and Young 2000). However, understory components of this community type are strongly affected by substrate

characteristics, resulting in considerable compositional variation among assemblages broadly grouped together as “pinyon-juniper woodlands” (West and Young 2000). Though heterogeneous, pinyon-juniper woodland is the most common ecosystem of the NCPN.

-Biological Soil Crusts: biological soil crusts composed of cyanobacteria, mosses, lichens, liverworts, microfungi, and green algae are significant components of most arid-semiarid ecosystems. Where they occur undisturbed, biological soil crusts are major contributors to ecosystem function (soil stability, nutrient cycling, hydrologic function) and biodiversity (Belnap and Lange 2001). Biological soil crusts have been described as “ecosystem engineers” because of their disproportionate effects on the structure and function of arid-semiarid ecosystems (Jones et al. 1994). As a consequence of their contributions to ecosystem function and diversity, biological soil crusts are among the most significant NCPN natural resources.

Montane Shrubland, Coniferous Woodland, and Forest Ecosystems

-Montane Shrublands: transitional between pinyon-juniper woodlands and lower montane coniferous forests, these mostly deciduous shrublands typically are dominated by *Quercus gambelii, Cercocarpus montanus, C. ledifolius, Amelanchier* spp., *Symphoricarpos* spp., and *Purshia* spp. Evergreen oaks (e.g., *Q. turbinella*) enter this association at the southern margin of the NCPN at ZION. This ecosystem is a landscape dominant at BLCA and is common at several other NCPN units. This type of deciduous shrubland has also been referred to as petran chaparral and Great Basin montane scrubland (Brown 1982, Floyd et al. 2000).

-Ponderosa Pine Woodlands and Forests: dominated by *Pinus ponderosa*, this is the most extensive type of ecosystem in the Mogollon Rim region of the southern Colorado Plateau and is common in the lower montane zones on mountains elsewhere on the Plateau (Peet 2000). Tree density and understory composition in this type are strongly dependent on disturbance history. Ecosystems dominated by *P. ponderosa* are most extensive at BRCA (Stein 1988), ZION (Madany and West 1983), DINO, and CURE.

-Douglas Fir Forests: dominated by *Pseudotsuga menziesii*, this forest type often replaces *Pinus ponderosa* forests successionally in the absence of fire, and spatially along a gradient of increasing soil moisture (Peet 2000). Thus ecosystems structurally dominated by *P. menziesii* typically intergrade with those dominated by *Pinus ponderosa* in relation to disturbance history and topographic aspect. Among NCPN units, *P. menziesii* ecosystems are most extensive at BRCA, ZION, and DINO. At CANY and several other relatively low-elevation parks, isolated stands of *P. menziesii* commonly are found in favorable microsites at the bases of north-facing cliffs.

-Aspen Forests: dominated by *Populus tremuloides*, these forests often replace those dominated by *Pinus ponderosa* and/or *Pseudotsuga menziesii* following fire and are subsequently replaced again by the conifers following long fire-free periods (Peet 2000). On the Colorado Plateau, clonal aspen populations appear to have dominated some high-

elevation shale-derived soils for thousands of years without replacement by conifers, possibly due to conifer intolerance of clay soils (Betancourt 1990).
Extensive stands of *Populus tremuloides* are uncommon in the NCPN, but sparse isolated stands are found in many parks. This type of ecosystem is most extensive at FOBU.

-Montane Meadows and Shrubland Parks: dominated by herbaceous vegetation and/or low shrubs (e.g., *Artemisia nova*), this ecosystem type is typically interspersed with forested ecosystems. Several hypotheses have been posed to explain the persistent presence of herb- and/or shrub-dominated vegetation in the midst of otherwise forested landscapes. In general, most montane meadows are associated with edaphic, disturbance, or air-drainage patterns that constrain tree recruitment (Peet 2000). In the NCPN, montane meadows and shrubland parks are important landscape components at CEBR and BRCA.

-Spruce-Fir Forests: characteristic of the subalpine zones of Colorado Plateau mountains and the Rocky Mountain region generally, these forests typically are dominated by *Picea engelmannii* and *Abies lasiocarpa* (Peet 2000). Among NCPN units, these forests are most extensive at CEBR, BRCA, and on north-facing canyon slopes at TICA. Sparse spruce-fir communities also are found on steep canyon slopes at BLCA and in favorable canyon microsites both at BLCA and CURE.

-Subalpine Woodlands: dominated by sparse stands of *Pinus longaeva* (western bristlecone pine), these ecosystems typically occur on high-elevation ridges exposed to desiccating winds or on high-elevation exposures of calcareous geologic substrates; frequently, these two factors coincide. *Pinus flexilis* (limber pine) may also occur in this woodland ecosystem. Soils are skeletal and under-story vegetation uncommon (Buchanan 1992). In contrast with the other montane ecosystems in this group, fire is relatively unimportant as a natural disturbance in these sparse woodland ecosystems (Bradley et al. 1992). Among NCPN units, bristlecone-limber pine woodlands occur primarily at CEBR and BRCA where they are associated with exposed ridges and cliff faces of the Claron Formation. At CARE, this ecosystem is found on high-elevation exposures of the Carmel Formation.

Riparian, Wetland and Aquatic Ecosystems

Riparian, wetland and aquatic ecosystems are important contributors to landscape-level diversity, ecological integrity, and connectivity of NCPN units. As a consequence, they are clearly among the most significant natural resources of this predominantly arid network. The structure, function and sustainability of these keystone ecosystems depend fundamentally on the quality and quantity of water resources. The ecological significance of water resources cannot be overemphasized. Brief descriptions of aquatic, riparian and wetland ecosystems follow, including discussions of impaired and pristine waters of the NCPN. Significant waters identified by park staff are listed in Table 7 and described in greater detail in park-specific water-resource descriptions in Appendix F. Protected uses of NCPN park waters are listed below.

-Slickrock Potholes and Waterpockets: deep weathering pits formed in sandstone support unique aquatic ecosystems of varying longevity. These range from truly ephemeral systems that emerge and disappear in relation to individual precipitation events, to deep aquatic systems that persist for months or indefinite long periods of time.
Slickrock potholes are particularly characteristic of sandstone exposures found at ARCH, CANY, CARE, and ZION.

-Hanging Gardens: these unique, insular riparian and aquatic ecosystems located in rock alcoves and beneath canyon pour-offs are diverse and productive (Welsh and Toft 1981, Fowler 1995). Common vascular plants include *Adiantum capillus-veneris*, *Petrophytum caespitosum, Epipactis gigantea, Carex aurea,* and *Mimulus* spp. Several Colorado Plateau endemics are found almost exclusively in hanging gardens, including *Primulus specuicola* and *Cirsium rydbergii*. Although hanging gardens are found in most NCPN units, the distribution, characteristics, and potential threats to these ecosystems have not been well documented. Because of their diversity and distinctive characteristics, hanging gardens are among the most significant natural resources of the NCPN.

Table 7. Significant water bodies identified by parks, Northern Colorado Plateau Network.

Park	Perennial streams (no.)	Intermittent streams (no.)	Ponds (no.)	Reservoirs (no.)	Mapped springs (no.)	Unmapped springs (est. no.)	Hanging gardens (est. no.)	Water pockets (est. no.)	303(d) list*	ONRW**	Significant water bodies	Comments
ARCH	1	7	0	0	13	unk.	unk.	unk.	none	none	Salt Wash (perennial), Courthouse Wash, Freshwater Canyon, Sleepy Hollow, Seven Mile Canyon, Salt Valley Wash, Salt Wash, Salt Spring, Willow Spring, Lost Spring Canyon	
BLCA	1	3	0	0	0	unk.	unk.	none	Red Rock Creek	pending	Gunnison R. below Aspinall, Red Rock Cr., Grizzly Gulch, Deadhorse Gulch	Park notes impaired condition of Red Rock Cr., 3 reservoirs on Grizzly Gulch
BRCA	0	7	0	0	13	unk.	none	none	none	none	East Cr., Yellow Cr., Sheep Cr., Bryce Cr., Swamp Canyon, Campbell Cr., Podunk Cr.	
CANY	3	8	0	0	122	unk.	unk.	unk.	none	none	Green R., Colorado R., Salt Cr., Davis Canyon, Lost Canyon, Little Spring Canyon, Horseshoe Canyon, Lavender Canyon, Jasper Canyon, Squaw Canyon, Water Canyon	
CARE	4	4	0	0	3	unk.	unk.	unk.	Fremont River	none	Fremont R., Sulphur Cr., Pleasant Cr., Oak Cr., Halls Cr., Polk/Bulberry Cr., Deep Cr., Middle Desert Wash, waterpockets & springs	
CEBR	1	5	1	0	0	unk.	none	unk.	none	none	Blowhard Spring, Shooting Star Spring, Twin Spring, Sunset Spring, Unnamed Spring	
COLM	0	5	0	0	0	unk.	unk.	unk.	none	none	None named	

Table 7 cont.

Park	Perennial streams (no.)	Intermittent streams (no.)	Ponds (no.)	Reservoirs (no.)	Mapped springs (no.)	Unmapped springs (est. no.)	Hanging gardens (est. no.)	Water pockets (est. no.)	303(d) list*	ONRW**	Significant water bodies	Comments
CURE	20	unk.	0	3	0	unk.	unk.	none	none	pending	Gunnison R. above and below reservoirs; Blue Mesa, Morrow Point, and Crystal reservoirs; Cimarron R., N. and S. Beaver Cr., Steuben Cr., Stevens Cr., N. Willow Cr., West Elk Cr., East Elk Cr., Soap Cr., Cebolla Cr., Lake Fork of the Gunnison R., Pine Cr., Blue Cr., Curecanti Cr., Corral Cr., Round Coral Cr., Mesa Cr., Crystal Cr., Myer's Gulch, Pool Gulch, Red Cr., canyon springs and seeps	
DINO	2	unk.	unk.	0	36	unk.	unk.	unk.	none	none	Green and Yampa rivers, streams and springs	
FOBU	0	3	0	0	0	unk.	none	none	none	none	Spring #1, Spring #2, Millet Canyon, Murder Hill Canyon, Moosebones Canyon, Cundick Spring	
GOSP	1	0	0	0	0	none	none	none	none	none	Blue Cr.	
HOVE	0	4	0	0	1	unk.	none	none	none	none	Little Ruin Canyon, Hackberry Canyon, Cajon Spring, Cutthroat Canyon, Goodman Point Canyon	
NABR	0	4	0	0	1	unk.	unk.	unk.	none	none	Tuwa Canyon, White Canyon, Armstrong Canyon, To-ko-chi Canyon, seeps	
PISP	0	0	2	0	0	none	unk.	none	none	none	Main Spring, Fort Spring, Ponds, Tunnel Spring, West Cabin Spring	
TICA	1	0	3	0	0	none	none	none	none	none	American Fork R., Timpanogos Cave pools	
ZION	9	unk.	unk.	0	9	100s	16	unk.	North Creek	none	N. and E. Fork Virgin rivers, Kolob Cr., Pine Cr., Orderville Canyon, Deep Cr., Shunes Cr., North Cr., La Verkin Cr., waterpockets and hanging gardens	Utah DEQ will attempt to remove North Cr. within park from 303(d) - data do not support listing.

Protected Uses for Northern Colorado Plateau Parks in Utah, Wyoming, Arizona and Colorado

The following tables summarize protected uses as identified by the states of Utah, Wyoming, Arizona, and Colorado for Northern Colorado Plateau Parks. Numeric standards for water quality are specific to these protected uses.

Table 8. Protected uses designated for Northern Colorado Plateau Parks in Utah.

UTAH PARK UNIT	WATERS IN PARK	REFERENCE TO STATE SEGMENT	Utah High Quality Cat. 2[1]	UTAH PROTECTED USES (See Table 5 for Definitions of Use Codes)						
				1C	2B	3A	3B	3C	3D	4
Hovenweep NM	See Table 9 below	San Juan River								
Bryce Canyon NP	East	Paria River			■					■
	West	East Fork Sevier River, Annabelle Diversion to headwaters and Tropic Res.	■		■	■				■
Zion NP	Kolob Area (Taylor Creek, Camp Creek)	Ash Creek above Ash Creek Res.			■	■				■
	North Fork Virgin River and tributaries.	North Fork Virgin River confluence w/ E. Fork to headwaters	■	■	■	■				■
	East Fork Virgin River	East Fork Virgin River confluence w/ N. Fork to headwaters	■		■	■				■
	Kolob Creek	Kolob Creek, confluence with N. Fork V. R. to headwaters			■	■				■
	Kolob Reservoir & Navajo Lake (both outside Park)	Kolob Reservoir and Navajo Lake			■	■				■
Zion NP	North Creek, Coalpits Wash	Virgin River upstream of Quail Creek Diversion		■	■			■		■
	LaVerkin Creek	Virgin River below Quail Creek Diversion			■		■			■
Cedar Breaks NM	West Slope	Coal Creek and tributaries			■			■		■
	East Slope	Duck Creek and tributaries		■	■	■				■
Timpanogos Cave NM	All	American Fork River			■	■				■
Dinosaur NM	See Table 4 below			■	■		■			■
Natural Bridges NM	All (White Canyon)	Lake Powell and all tributaries			■		■			■

Table 8 cont.

UTAH PARK UNIT	WATERS IN PARK	REFERENCE TO STATE SEGMENT	Utah High Quality Cat. 2[1]	UTAH PROTECTED USES (See Table 5 for Definitions of Use Codes)						
				1C	2B	3A	3B	3C	3D	4
Golden Spike NHS	Blue Creek	Blue Creek from Great Salt Lake to Blue Cr. Res.			■				■	■
Capitol Reef NP	Fremont R. Downstream of CARE (Harnet Draw, Sandy & Oak Cr. in park)	Fremont River and tributaries from the confluence with Muddy Cr. To CARE			■			■		■
	Fremont River in CARE and upstream	Fremont River and tributaries through CARE to Headwaters		■	■	■				■
	Pleasant Creek inside CARE	Pleasant Creek and tributaries, from confluence with Fremont River to E. boundary of CARE			■			■		
	Pleasant Cr. upstream of CARE (outside of Park)	Pleasant Cr. and tributaries from east boundary of Capitol Reef to headwaters		■	■	■				
	Halls Creek (Bitter Cr. Divide South in park)	All tributaries to Lake Powell except as listed separately			■		■			■
	Southwestern Margin of park	Escalante River and tributaries, from Lake Powell to confluence with Boulder Creek			■			■		
Arches NP	All	Colorado R. and tributaries from Lake Powell to state line		■	■		■			■
Canyonlands NP	Most of Park	Colorado R. and tributaries from Lake Powel l to state line, and Green River and tributaries from confluence with Colorado R. to State Line		■	■		■			■
	Immediate vicinity of Indian Cr. confluence and southeastern-most margin of park.	Indian Creek and tributaries from confluence with Colorado R. to Newspaper Rock State Park			■		■			■
	Southwestern-most margin of park	All Tributaries to Lake Powell except as listed separately			■		■			■

[1] High Quality category 2 designation in Utah does not carry with it specific numeric criteria at this time.

Table 9. Protected uses designated for Northern Colorado Plateau Parks in Wyoming.

Wyoming				
PARK	**WATERS IN PARK**	**REFERENCE TO STATE SEGMENT**	**CLASS**	**PROTECTED USES**
Fossil Butte NM	Chicken Creek Watershed and North East Slopes draining to North Fork Twin Cr.	Chicken Creek, tributary to Twin Creek and North Fork of Twin Creek in Lincoln County	3B	Scenic Value, Industry, Agriculture, Wildlife, Recreation, Other Aquatic Life (NOT Protected are: Drinking Water, Game Fish, Non-Game Fish, and Fish Consumption)
	Western Slopes draining to Rock Creek. Southern Slopes draining to Twin Creek, including Smallpox Cr.	Rock Creek, tributary to Twin Creek Twin Creek, tributary to Bear River	2AB	All (Drinking Water, Game Fish, Non-Game Fish, and Fish Consumption, Other Aquatic Life, Recreation, Wildlife, Agriculture, Industry, and Scenic)

Table 10. Protected uses designated for Northern Colorado Plateau Parks in Arizona.

Arizona			
PARK	**WATERS IN PARK**	**REFERENCE TO STATE SEGMENT**	Protected Uses
Pipe Spring NM	All	Kanab Creek	Aquatic and Wildlife warm water, Full-body Contact, Domestic Water Source, Fish Consumption, Agricultural Irrigation

Table 11. Protected uses designated for Northern Colorado Plateau Parks in Colorado (including portions of Dinosaur and Hovenweep National Monuments in Utah).

Segment Description[1]	Water Body Identification Code (305b Water Body Identification Code) [2]	Miles (In Park)	Shoreline Miles [3]	Acres (In Park)	State-Designated Uses Applied to this Segment (See Table 5 for Definitions of Use Codes)											
					Colorado							Utah				
					AG	ALCW1	ALWW1	ALWW2	DWS	RPC	RSC	1C	2B	3A	3B	4
Dinosaur National Monument																
CO Region 11, LY/G Basin, Segment 2 Mainstem of the Yampa River from a point immediately above the confluence with Lay Creek to the confluence with the Green River.	COLCLY02 (COLCLY02_8100)	48.23		2.92	■		■		■	■						
CO Region 11, LY/G Basin, Segment 14 All Tributaries to the Yamps River, including all wetlands, lakes and reservoirs from a point immediately below the confluence with Lay Creek to a point immediately below the confluence with the Little Snake River.	COLCLY14 (COLCLY14_8100)	230.98			■			■			■					
CO Region 11, LY/G Basin, Segment 19 Mainstem of the Green River within Colorado (Moffatt County)	COLCLY19 (COLCLY19_7800)	25.32		48.65	■	■			■	■						
CO Region 11, LY/G Basin, Segment 20 All tributaries to the Green River in Colorado, including all wetlands, lakes and reservoirs, except for the specific listings in segments 21 and 22; all tributaries of the Yampa River from a point immediately below the confluence with the Green River, except for the specific listings in segments 15 through 18.	COLCLY20 (COLCLY20_7800)	74.28			■			■		■						
CO Region 11, White R. Basin, Segment 22 All Tributaries to the White River, including all wetlands, lakes and reservoirs, from a point immediately above the confluence with Douglas Creek to the Colorado/Utah border, except for the specific listing in Segment 23.	COLCWH22 (COLCWH22_8500)	0.99			■			■		■						

Table 11 continued

Segment Description[1]	Water Body Identification Code (305b Water Body Identification Code) [2]	Miles (In Park)	Shoreline Miles [3]	Acres (In Park)	State-Designated Uses Applied to this Segment (See Table 5 for Definitions of Use Codes)											
					Colorado							Utah				
					AG	ALCW1	ALWW1	ALWW2	DWS	RPC	RSC	1C	2B	3A	3B	4
Dinosaur National Monument - Utah Portions																
Green River and tributaries from the confluence with Colorado River to State Line, except for the two segments listed below.	UT-R-GREEN-0001 (UT14060001-001_00)	140.18	0.5	4.68								■	■		■	■
Big Brush Creek and tributaries from confluence with Green River to Tyzack (Red Fleet) Dam.	UT-R-GREEN-0034 (UT14060002-003_00)	0.95											■		■	■
Jones Hole Creek and Tributaries from confluence with Green River to headwaters. Utah as High Quality Category 2, which provides narrative standards for antidegradation.	UT-R-GREEN-0036 (UT14060001-002_00)	6.33											■	■		■
Black Canyon of the Gunnison National Park																
CO Region 10, Basin – Lower Gunnison R., Segment 1. Mainstem of the Gunnison River from the outlet of Crystal Reservoir to a point immediately above the confluence with the Uncompahgre River	COGULG01 (COGULG01_6800)	11.93			■	■			■	■						
CO Region 10, Basin – Lower Gunnison R., Segment 4a. All tributaries to the Gunnison River, including all wetlands which are not on national forest lands, from the outlet of Crystal Reservoir to the confluence with the Colorado River.	COGULG04A (COGULG04_6800)	16.15			■			■	■		■					
Curecanti National Recreation Area																
CO Region 10, Basin – Lower Gunnison R., Segment 1. Mainstem of the Gunnison River from the outlet of Crystal Reservoir to a point immediately above the confluence with the Uncompahgre River	COGULG01 (COGULG01_6800)	2.26			■	■			■	■						

Table 11 continued

Segment Description[1]	Water Body Identification Code (305b Water Body Identification Code) [2]	Miles (In Park)	Shoreline Miles [3]	Acres (In Park)	State-Designated Uses Applied to this Segment (See Table 5 for Definitions of Use Codes)												
					Colorado							Utah					
					AG	ALCW1	ALWW1	ALWW2	DWS	RPC	RSC	1C	2B	3A	3B	4	
CO Region 10, Basin – Lower Gunnison R., Segment 4a. All tributaries to the Gunnison River, including all wetlands which are not on national forest lands, from the outlet of Crystal Reservoir to the confluence with the Colorado River.	COGULG04A (COGULG04A_6800)	0.60			■			■	■		■						
CO Region 10, Basin – Upper Gunnison R., Segment 14. Mainstem of the Gunnison River from the confluence of the East and Taylor rivers to the inlet of Blue Mesa Reservoir.	COGUUG14 (COGUUG14_6800)	4.61	5.34	169.10	■	■			■	■							
CO Region 10, Basin – Upper Gunnison R., Segment 25. Blue Mesa, Morrow Point and Crystal Reservoirs and those segments of the Gunnison River which inter-connect reservoirs.	COGUUG25 (COGUUG25_6800)	64.05	100.30	9421.83	■	■			■	■							
Curecanti National Recreation Area (continued)																	
CO Region 10, Basin – Upper Gunnison R., Segment 26. All tributaries, from the source, to those waters described in segment 25 including all lakes, reservoirs and wetlands which are on Gunnison and Uncompahgre National Forest lands, or which flow into or are present within Curecanti National Recreation Area with the exception of Segments 14, and 29.	COGUUG26 (COGUUG26_6800)	19.88	3.90	67.27	■	■			■		■						
CO Region 10, Basin – Upper Gunnison R., Segment 29. Mainstem of Lake fork of the Gunnison including all tributaries, lakes, reservoirs and wetlands from the source to Blue Mesa Reservoir.	COGUUG29 (COGUUG29_6800)	9.68	16.01	533.58	■	■			■	■							

Table 11 continued

Segment Description[1]	Water Body Identification Code (305b Water Body Identification Code) [2]	Miles (In Park)	Shoreline Miles [3]	Acres (In Park)	State-Designated Uses Applied to this Segment (See Table 5 for Definitions of Use Codes)											
					Colorado							Utah				
					AG	ALCW1	ALWW1	ALWW2	DWS	RPC	RSC	1C	2B	3A	3B	4
Colorado National Monument																
CO Region 11, Basin – Lower Colorado River, Segment 13a: All Tributaries to the Colorado River, including all wetlands, lakes and reservoirs, from a point immediately below the confluence of Parachute Creek to the Colorado/Utah border except for the specific listings in segments 13b through 19. (13b is a temporary standard for streams NE of park boundary, other exceptions are N/A)	COLCLC13A (COLCLC13A_6500)	54.46			■			■		■						
Hovenweep National Monument																
CO Region 9, Basin -La Plata R., Mancos R. McElmo Cr., and San Juan R. in Montezuma County and Delores County, Segment 7a: Mainstem of McElmo Creek from the source to the Colorado/Utah Border. Mainstem of Yellow Jacket Creek, including all tributaries, wetlands, lakes and reservoirs from the source to the confluence with McElmo Creek.					■			■		■						
Utah Units – all San Juan River and its tributaries												■	■		■	■

[1] Segment Descriptions are taken verbatim from the State of Colorado Stream Classifications and Water Quality Standards except that references to exceptions that do not pertain to the park have been deleted. (e.g. where the description says "except for the specific listings for segments 3a to 6," this text has been deleted if segments 3a to 6 are not located in or near the park.)

[2] The Water Body Identification Code is a state-assigned identifier for each reach. The Water Body Identification Codes used in 303d reports may include more than one WBID, or may include only a part of one WBID.

[3] Shoreline Miles applies to adjacent lakes/ponds, seas/oceans, swamps/marshes, reservoirs or estuaries.

Table 12. Definitions of Colorado and Utah designated protected uses.

State-Designated Use Codes	State-Designated Use	Definition
Colorado		
AG	Agriculture	These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.
ALCW1	Aquatic Life Cold Water-Class 1	These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of abundance and diversity of species.
ALWW1	Aquatic Life Warm Water-Class 1	These are waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of abundance and diversity of species.
ALWW2	Aquatic Life Warm Water-Class 2	These waters are not capable of sustaining a wide variety of warm water biota, including sensitive species, due to physical habitat, water flows or levels, or uncorrectable water quality conditions that result in substantial impairment of the abundance and diversity of species.
DWS	Water Supply	These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments or supplements thereto.
RPC	Recreation 1 - Primary Contact	These surface waters are suitable or intended to become suitable for recreational uses in or on the water when the ingestion of small quantities of water is likely to occur. Such waters include but are not limited to those used for swimming, rafting, kayaking and water-skiing.
RSC	Recreation 2 - Secondary Contact	These surface waters are suitable or intended to become suitable for recreational uses on or about the water which are not included in the primary contact subcategory, including but not limited to fishing and other streamside or lakeside recreation.

Table 12 continued

State-Designated Use Codes	State-Designated Use	Definition
Utah		
1C	Drinking Water Supply	Protected for domestic purposes with prior treatment by processes as required by the Utah Department of Health.
2A	Primary Contact (Recreation)	Protected for primary contact recreation such as swimming.
2B	Secondary Contact (Recreation)	Protected for secondary contact recreation such as boating, wading, or similar uses.
3A	Cold Water Game Fish	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3B	Warm Water Game Fish	Protected for warm water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3C	Nongame Fish	Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
3D	Waterfowl	Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
3E	Severely Habitat Limited	Severely habitat limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
4	Agriculture	Protected for agricultural uses including crop irrigation and stock watering.
5	Great Salt Lake	Protected for primary and secondary contact recreation, aquatic wildlife, and mineral extraction.

Sources: Adapted from National Park Service 2003a, 2003b, 2003c, and 2003d, which used Environmental Protection Agency WQSDB (Version 3) (2003), and State of Utah (1997) as primary sources.

-Perennial Wetlands: ecosystems with vegetation dominated by sedges (*Carex* spp.), rushes (*Juncus* spp.), spikerushes (*Eleocharis* spp.), and cattails (*Typha* spp.) are present but uncommon on the Colorado Plateau (West and Young 2000). Because of their comparative rarity and diversity, as well as their association with surface water, wetland ecosystems possess particularly high conservation value.

-Reservoirs: Although artificial in nature, these aquatic ecosystems are important resources that support diverse biotic assemblages and high levels of recreational use. In the NCPN, this type of ecosystem is found only at CURE.

-Rivers and Streams with Associated Aquatic and Riparian Ecosystems: in terms of spatial extent, rivers and streams with their associated aquatic and riparian ecosystems are relatively minor landscape components in most NCPN units. However, where present, these ecosystem complexes contribute disproportionately to the diversity, integrity, and conservation value of NCPN landscapes. At low and intermediate elevations across the Colorado Plateau, *Populus fremontii* and *Salix exigua* dominate streamside riparian woodlands (MacMahon 1988). In many drainages, these native cottonwoods and willows face considerable competition from exotic *Tamarix* spp. and *Elaeagnus angustifolia*. At higher elevations, *Populus angustifolia, Alnus* spp., *Acer negundo, Betula occidentalis, Shepherdia argentea,* and several *Salix* spp. dominate comparable riparian ecosystems (Peet 2000). Major rivers that flow through or adjacent to NCPN units include the Colorado River (CANY and ARCH), the Gunnison River (BLCA and CURE), the Fremont River (CARE), the Yampa and Green Rivers (DINO), the American Fork River (TICA), and the Virgin River (ZION). Aquatic and forested riparian ecosystems associated with large streams and rivers are among the most critically endangered ecosystems in the nation, and they have been particularly impacted by land-use activities in the arid-semiarid West (Noss et al. 1995). Because of their importance to individual parks as well as their degree of national imperilment, these ecosystems have been identified as among the most significant natural NCPN resources.

Description of 303d Waters in NCPN Park Units

Under the Clean Water Act (CWA), states must identify all waters that do not meet or are not expected to meet water quality standards. The identification and public notification of water-quality-limited waters is accomplished through what has become known as "303(d) lists" after the CWA section where the requirement is contained (NPS 2001a). States are required to perform an analysis of the cause(s) of this non-attainment of standards and develop a plan for bringing the problem water body into compliance. These plans analyze the Total Maximum Daily Loading of contaminants to the water and are therefore referred to as "TMDL" plans. States can consider a wide variety of remedies including reducing the contaminant loading, changing the designated protected uses (such as from Cold Water Fishery to Warm Water Fishery) to more accurately reflect ambient conditions, or documenting that the "poor" quality of the water is due to natural causes and is not correctable.

Three water sources in parks in the NCPN have been reported on the non-attainment or 303d list (Fig. 5). These are:

North Creek in ZION is listed for Total Dissolved Solids with 39% of samples between 1996 and 2002 exceeding the 1,200 mg/l standard. A TMDL analysis has been completed for North Creek, concluding that the high dissolved solids are primarily the result of natural conditions with minor contributions from agricultural runoff. The state will prepare a use attainability analysis to determine if the problem can be corrected, and if not suggest a new standard specific to this creek.

The Fremont River Upstream of CARE has had a TMDL analysis completed (September 2002) for total Phosphorus, Organic Enrichment and Low Dissolved Oxygen. The TMDL report identified numerous livestock feeding operations and other agricultural practices as contributors to the nutrient loading. Though the river segment found to not support the designated beneficial use ends at the park boundary, the affected water flows into the park. State monitoring at found the river to routinely exceed the standard for total phosphorus at Hickman Bridge inside the park. Additionally, a TMDL report has been completed for the Fremont River segment immediately downstream of the park for high salinity, total dissolved solids and chlorides. Both river segments are currently Category 4A, for waters that are impaired and have a completed TMDL.

Red Rock Creek in BLCA was recently added to the 303d list along with all "Gunnison River Tributaries between Crystal Creek and the Colorado River (not including USFS land)" for high selenium. The TMDL analysis for these waters is a high priority but has not been initiated at this time. Selenium is a widespread problem in the upper Colorado River Basin, in particular in streams that drain Mancos shale geology. Agricultural runoff from irrigated lands increases the contribution of selenium.

Additional waters of concern near NCPN units:

Kolob Reservoir upstream of ZION has been assigned category 5D by the Utah DEQ, meaning that it has been intermittently out of compliance for Dissolved Oxygen during some monitoring cycles, but not others. Should it be out of compliance for two consecutive monitoring periods it would be moved to the 303d list and be subject to a TMDL analysis? This reservoir is upstream of Zion National Park. The degree of concern on the part of the park for low dissolved oxygen is relatively low because the stream flows over numerous waterfalls as it descends over 3,000 feet in 7 miles of channel, so should be well oxygenated throughout.

Blue Creek upstream of GOSP is subject of a TMDL review of industrial discharges upstream of the park. The state of Utah categorizes it as a "5C" water, meaning that the permitted discharge loading to the stream is significant and requires TMDL analysis.

-Pristine Waters: the highest level of water-quality protection under standards associated with the CWA applies to certain waters that constitute an outstanding state or national resource. These waters, which are those designated as Outstanding Natural Resource Waters (ONRWs), shall be maintained and protected at their existing quality. Waters qualify for ONRW status if they are a significant attribute of a State Gold Medal Trout

Fishery, a national park, national monument, national wildlife refuge, a designated wilderness area, are part of a designated wild river under the Federal Wild and Scenic Rivers Act, or the waters have exceptional recreational or ecological significance, and have not been modified by human activities in a manner that substantially detracts from their value as a natural resource. A nomination and designation process is required to obtain administrative designations of ONRW status (NPS 2001a).

Currently, no NCPN parks have waters with designated ONRW status. However, BLCA and CURE are pursuing ONRW status for selected high-quality waters. These parks have collected water-quality data since the 1980s as part of a baseline water-quality monitoring program. These data are being used to determine constituent fluxes into the reservoir system and to characterize existing water-quality conditions in an area experiencing rapid increases in land-use intensity, population, and recreational use. Based on limited data and types of constituents collected, certain streams and rivers have shown existing water quality that is of higher quality than standards directed by the CWA and enacted by Colorado. Recent explosive and potential future growth surrounding these parks has prompted an investigation into the feasibility of attaining ONRW status for selected waters. This designation will protect the waters of BLCA and CURE beyond current standards, consistent with Servicewide and park guidelines.

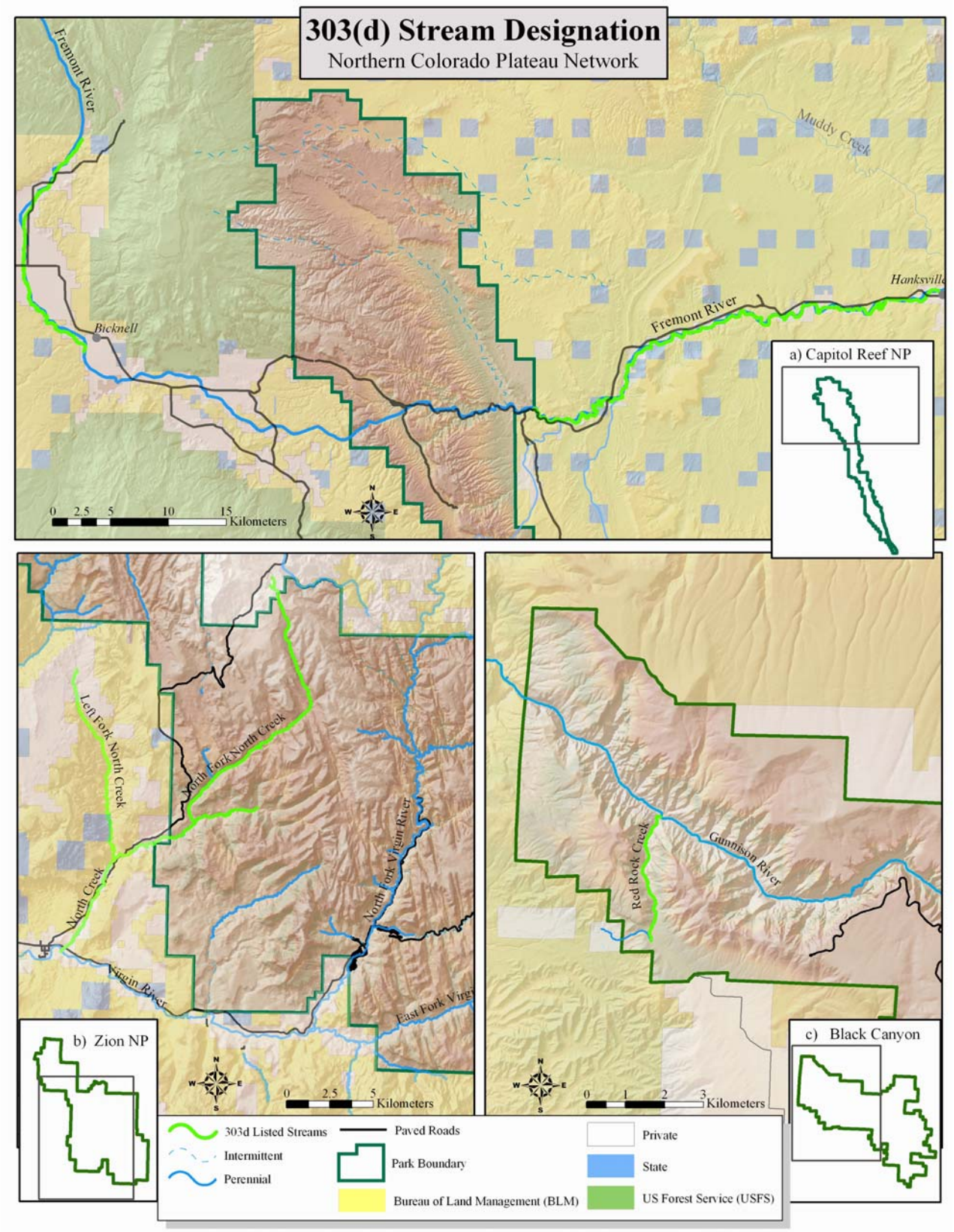


Figure 5. Reaches of the Fremont River near Capitol Reef National Park (a), of North Creek in Zion National Park (b), and Red Rock Creek in Black Canyon (c) that currently are listed as water-quality impaired on Utah 303(d) list (Utah DEQ 2002) and Colorado.

Table 13. Approximate taxonomic richness of Northern Colorado Plateau Network parks and monuments. Values were derived from the number of occurrences in the NPSpecies database and include all taxa that were annotated as confirmed, probably present, unconfirmed, or historic as of 8/16/02.

	Approximate richness by taxonomic group						
Park code	Vascular plants	Fish	Amphibians	Reptiles	Birds	Mammals	TOTAL
ARCH	475	31	9	22	207	74	818
BLCA	265	14	8	14	160	75	536
BRCA	461	1	7	16	217	79	781
CANY	628	31	10	25	218	81	993
CARE	1092	8	7	21	228	84	1440
CEBR	279	1	3	11	143	71	508
COLM	331	0	8	19	147	66	571
CURE	339	16	4	8	192	74	633
DINO	588	31	7	18	244	74	962
FOBU	524	0	6	9	178	75	792
GOSP	120	0	6	17	103	80	326
HOVE	274	0	9	23	147	71	524
NABR	431	0	10	25	208	76	750
PISP	165	1	9	26	78	70	349
TICA	247	3	4	15	164	75	508
ZION	922	9	10	47	262	87	1337

Species

Estimated richness of vascular plants and vertebrates varies considerably among NCPN units (Table 8). CARE and ZION have the largest known floras; DINO, CANY, and ARCH have the most fish taxa; CANY, NABR, and ZION have the most amphibians; ZION by far has the most reptile taxa; ZION, DINO, and CARE have the most birds; and ZION and CARE have the most mammals. Combined richness in these groups is greatest at ZION and CARE. Previous work investigating patterns of floristic richness on the Colorado Plateau has found vertical relief to be the single environmental variable most positively correlated with the number of vascular plants documented for particular land units (J. Spence, personal communication). In the NCPN data set, floristic richness is also significantly correlated with vertical relief ($r = 0.75$, $p < 0.05$), probably because vertical relief serves as a coarse indicator of habitat diversity.

Floristic Distinctiveness

The Colorado Plateau is a center of plant speciation and endemism. Although no attempt has been made to determine the size of the flora, there are an estimated 2500-3000 species. About 10 percent of this flora is endemic (Schultz 1993), consisting mostly of herbaceous dicots in the genera *Astragalus*, *Cryptantha*, *Erigeron*, *Eriogonum*, *Gilia*, *Phacelia*, and *Penstemon*. Holmgren (1972) described floristic sections of the Intermountain Region and observed that the Canyonlands floristic section, which in part coincides with the Northern Canyonlands Section (Fig. 4), is by far the richest part of the Intermountain Region in terms of plant endemism. The Uinta Basin and the Utah High Plateaus and Mountains sections also have relatively high numbers of narrow endemics. Notably, many of the Utah High Plateau endemics are restricted almost entirely to the Claron Formation, which is exposed so dramatically at CEBR and BRCA (Utah Division of Wildlife Resources 1998).

The Claron example supports the important generalization that plant endemism on the Colorado Plateau is highly correlated with the exposure of raw geologic substrates or unweathered colluvium (Welsh 1978, 1979, Welsh et al. 1993). In the Uinta Basin and Northern Canyonlands sections, geologic substrates that support disproportionately high numbers of narrow endemics include shales, siltstones, mudstones, and sandstones, as well as materials derived from these (Welsh 1979). Important geologic formations in terms of endemic plants include many of those shared by NCPN parks (Table 1): Cedar Mesa, Cutler, Moenkopi, Chinle, Navajo, Carmel, Entrada, Morrison, Dakota, Mancos / Tropic, and Claron (Welsh 1979).

Through quantitative analyses of local floras of the western United States, McLaughlin (1986, 1989, and 1992) recognized the existence of a distinct Colorado Plateau floristic subprovince. Within the Colorado Plateau subprovince, he recognized a northern Colorado Plateau floristic district and a southern Colorado Plateau floristic district based on the occurrence and range of narrowly distributed species (endemics). Of NCPN units, DINO, CANY, CARE, ARCH, HOVE, and COLM were in the area delimited as the northern Colorado Plateau floristic district, whereas BRCA, ZION, NABR, and PISP were in the southern Colorado Plateau floristic district. Remaining NCPN units were placed in one of several surrounding floristic districts.

Conservation Status

Based on information in the NPS Endangered Species Program database as of June 2002, 25 taxa with Federal Endangered Species Act (ESA) status are considered by park staff to occur in NCPN parks or monuments (Table 9). These include 1) taxa that are currently listed as threatened or endangered, 2) taxa that are candidates for listing, 3) taxa that recently have been delisted, and 4) taxa that are managed under conservation agreements with the U.S. Fish and Wildlife service but are not listed as threatened or endangered. Among the 25 taxa are 11 vascular plant species, five fish species, one reptile species, seven bird species, and one mammal species. Most listed plants are rare edaphic endemics. Taxa with the widest distribution among NCPN parks are the recently delisted American peregrine falcon (*Falco peregrinus anatum*) and the bald eagle (*Haliaeetus leucocephalus*)—a taxon proposed for delisting. Similar to the general patterns in species richness described above, CARE and ZION have the largest numbers of listed taxa in the NCPN (Table 10).

Tables 9 and 10 understate the number of rare and sensitive species that occur in (or potentially occur in) NCPN parks. For example, DINO and CARE each have over 40 vascular plant taxa that are considered sensitive by park staff. These are primarily rare edaphic endemics with conservation ranks of G3 and above (see footer to Table 9 for explanation of heritage conservation ranks and codes). Relatively large numbers of rare plant taxa also are found at ARCH, CARE, CANY, BRCA, and ZION. The NCPN is currently working to develop a standard approach for determining sensitive species on a networkwide basis.

In addition to these rare but unlisted taxa, several listed or candidate taxa could potentially occur in NCPN units where they have not yet been documented. Examples include the southwestern willow flycatcher (*Empidonax traillii extimus*) at ARCH and CANY and the Gunnison sage grouse (*Centrocercus minimus*) at HOVE and COLM.

Temporal Patterns of Ecosystem Change: Pleistocene to Current
Paleoecological studies allow extant terrestrial ecosystems to be viewed in a broader temporal context. For example, late-Pleistocene alpine glaciers probably occupied the current site of CEBR until about 13,000 years ago (13 ka) (Anderson et al. 1999). Pollen and macrofossils in sediment cores suggest that subalpine coniferous forests dominated by *Picea* (spruce) and *Abies* (fir) became established at current elevations in the Utah High Plateaus and Mountains by about 9.8 ka. With some fluctuations, *Picea-Abies* forests generally have dominated high Plateau ecosystems throughout the Holocene.

Plant macrofossils collected from *Neotoma* (packrat) middens provide a rich record of late-Pleistocene and Holocene environments at lower elevations across the Plateau. The Pleistocene-Holocene biogeography of the Colorado Plateau, as reflected by *Neotoma* middens, has been well described by Betancourt (1984, 1990); the following draws from his work. Relative to present, late-Pleistocene (13-10 ka) vegetation patterns were characterized by several distinctive features. Based on the absence of *Pinus ponderosa* (ponderosa pine) and *P. edulis* (pinyon pine) macrofossils from late-Pleistocene midden sequences, these two species were evidently displaced southward and completely absent from the Plateau as recently as 10 ka. During the late Pleistocene, montane coniferous woodlands dominated by *Pinus flexilis* (limber pine), *Juniperus scopulorum* (Rocky Mt. juniper), *Pseudotsuga menziesii* (Douglas-fir), *Picea pungens* (blue spruce), *Abies concolor* (white fir), and *Juniperus communis* (common juniper) probably occurred at elevations and landscape positions similar to those where *Juniperus osteosperma* and *Pinus edulis* are found today. Because of the absence of *P. ponderosa* and *P. edulis*, these late-Pleistocene coniferous woodlands would have occurred directly above *J. osteosperma* woodlands and arid-semiarid shrublands. The record provided by *Neotoma* middens clearly supports the ecological principle that species respond individualistically to environmental factors (including Pleistocene-Holocene climate changes) rather than as synchronized members of distinct plant communities. Thus many species assemblages of the late Pleistocene (e.g., *Picea pungens*, blue spruce, with *Atriplex canescens*, four-wing saltbush) have no modern counterparts. Relative to modern distributions, it can be said that individual species were elevationally displaced by 200–800 m during the late Pleistocene. Few, if any generalizations can be made concerning elevational displacements of intact biotic communities. Species assemblages and distributions that we now recognize as "modern vegetation" were established by about 3.4 ka on the Colorado Plateau.

Paleoecological studies conducted at ARCH generally support the scenario described above (Sharpe 1993). Evidence from *Neotoma* middens indicates that *Pinus flexilis* and *Pseudotsuga menziesii* dominated late-Pleistocene vegetation in a rock alcove currently

vegetated by *Juniperus osteosperma*, *Pinus edulis*, *Quercus gambelii*, various cacti, and herbaceous plants.
Relative to their current distributions, late-Pleistocene elevational displacements of *P. flexilis* and *P. menziesii* were 513 m and 208 m, respectively. Modern vegetation was established near the alcove prior to 2.7 ka.

In *Neotoma* midden studies conducted at CARE, Cole and colleagues (1997) concluded that the greatest vegetation changes evident in their 5400-year midden record were those that occurred during the past 200 years. They attributed the recent magnitude of vegetation changes to 19th-century grazing by sheep and cattle following Euro-American settlement. Livestock-palatable species such as *Stipa hymenoides* and *Ceratoides lanata* were consistently present throughout the pre-settlement midden record. These and several species palatable to sheep but not cattle were markedly absent in samples dated to the post-settlement period. Several species considered indicative of overgrazed rangelands were not present in the pre-settlement record but were abundant in the post-settlement record.

The research conducted by Cole and colleagues (1997) is instructive in its conclusion—current ecosystem conditions at CARE reflect the long-lived legacy of past and ongoing land-use activities. Although methods applied in this study are somewhat unusual, conclusions are not. Most NCPN units manage ecosystems that have been significantly altered by past and/or ongoing human activities. In many of these ecosystems, the "abnormal conditions" referred to in the Servicewide goals for vital signs monitoring were triggered and realized long ago. The existence of already-abnormal conditions presents challenges for the monitoring program, and suggests the need for explicit inventories of ecosystem conditions and restoration needs in conjunction with the development of the monitoring plan.

Table 14. Taxa with federal Endangered Species Act status (i.e., currently listed, candidates for listing, recently delisted, or managed under conservation agreements) that are considered by park staff to occur currently in Parks or Monuments of the Northern Colorado Plateau Network. Table is based on information in the NPS Endangered Species Program database as of June 2002. See table 10 for counts of listed taxa by park.

Taxonomic group Scientific name	Common name	Heritage Conservation Status*	Endangered Species Act Status**	Parks	Comments
Vascular plants					
Salix arizonica	Arizona willow	G2G3S2	M	CEBR	
Pediocactus despaini	Despain's cactus	G2	E	CARE	
Cycladenia humilis var. *jonesii*	Jones' cycladenia	G3G4T2	T	CARE	Chinle Fm.
Townsendia aprica	Last Chance townsendia	G2	T	CARE	Clay soils in Mancos & several other shale formations.
Erigeron maguirei	Maguire daisy	G2	T	CARE	Navajo Fm.
Astragalus eremiticus var. ampullarioides	Shivwits Milkvetch	G1S1Q	E	ZION	Chinle Fm.
Schoenocrambe barnebyi	Sye's Butte plainsmustard	G2	E	CARE	Moenkopi Fm.
Spiranthes diluvialis	Ute ladies' tresses	G2	T	CARE, DINO	
Pediocactus winkleri	Winkler's pin-cushion cactus	G2	T	CARE	Morrison & Dakota Fms.
Gilia caespitosa	Wonderland Alice-flower	G2	C	CARE	Navajo Fm.
Sclerocactus wrightiae	Wright fishhook cactus	G2	E	CARE	
Fish					
Gila elegans	Bonytail chub	G1	E	CANY, DINO	
Ptychocheilus lucius	Colorado pikeminnow	G1	E	CANY, DINO	
Gila cypha	Humpback chub	G1	E	CANY, DINO	
Xyrauchen texanus	Razorback sucker	G1	E	CANY, DINO	
Lepidomeda mollispinis	Virgin spinedace	G1	M	ZION	
Reptiles					
Gopherus agassizii	Desert tortoise	G4S1	T	ZION	
Birds					
Falco peregrinus anatum	American peregrine falcon	G4	DM	BLCA, BRCA, CARE, COLM, CURE, DINO, ZION	
Haliaeetus leucocephalus	Bald eagle	G4	T, AD	ARCH, BLCA, BRCA, CANY, CARE, COLM, CURE, DINO, GOSP, HOVE, ZION	
Gymnogyps californianus	California condor	G1	EXPN	ARCH, BRCA	
Centrocercus minimus	Gunnison sage grouse	G1	C	BLCA, CURE	
Strix occidentalis lucida	Mexican spotted owl	G3T3	T	BRCA, CANY, CARE, DINO, ZION	Not confirmed in BRCA, but surveys conducted for USFWS Endangered Species Act Sect. 7 projects.
Empidonax traillii extimus	Southwestern willow flycatcher	G5T2	E	BRCA, CARE, ZION	Not seen in BRCA since 1996.
Coccyzus americanus	Yellow-billed cuckoo	G5S1	C	CARE, ZION	
Mammals					
Cynomys parvidens	Utah prairie dog	G1	T	BRCA	

Table 15. Numbers of taxa with federal Endangered Species Act status (i.e., currently listed, candidates for listing, recently delisted, or managed under conservation agreements) that are considered by park staff to occur currently in Parks or Monuments of the Northern Colorado Plateau Network. Table is based on information in the NPS Endangered Species Program database as of June 2002. See Table 8 for identities of taxa in each park.

	Number of taxa by taxonomic group						
Park code	Vascular plants	Fish	Amphibians	Reptiles	Birds	Mammals	TOTAL
ARCH	-	-	-	-	2	-	2
BLCA	-	-	-	-	3	-	3
BRCA	-	-	-	-	5	1	6
CANY	-	4	-	-	2	-	6
CARE	9	-	-	-	5	-	14
CEBR	1	-	-	-	-	-	1
COLM	-	-	-	-	3	-	3
CURE	-	-	-	-	3	-	3
DINO	1	4	-	-	3	-	8
FOBU	-	-	-	-	-	-	-
GOSP	-	-	-	-	1	-	1
HOVE	-	-	-	-	1	-	1
NABR	-	-	-	-	-	-	-
PISP	-	-	-	-	-	-	-
TICA	-	-	-	-	-	-	-
ZION	1	1	-	1	5	-	8

Paleontological Resources

Geologic features are important controls of contemporary ecological patterns, but they also reflect environments of the long-distant past. Paleontological objects and features—remnant signs of life from that long-distant past—are also among the outstanding natural resources of NCPN units. DINO and FOBU were established precisely because of their wealth of paleontological resources, and many other network parks possess valuable resources of this type. In addition to DINO and FOBU, other network parks with significant paleontological resources include ARCH, BLCA, BRCA, CANY, CARE, COLM, CURE, HOVE, NABR, and ZION. The fossil-rich Morrison Formation which supports the dinosaur quarry at DINO is also exposed at ARCH, BLCA, CARE, COLM, CURE, and HOVE (Table 1).

Sensory Resources

In an increasingly urbanized world, sensory (or aesthetic) resources are among the most precious and valued resources of network parks. Sensory resources include nightskies populated by crystal-clear points of undiminished starlight and moonlight; soundscapes rich with unobscured sounds of organisms, wind, and water; and expansive, uncluttered, far-reaching viewscapes with clean air; and solitude. To varying degrees, these resources are important and outstanding characteristics of all network parks.

Northern Colorado Plateau Network Park Descriptions

ARCHES NATIONAL PARK (ARCH)

Size 30,966 hectares (76,519 acres)

Park History and Purpose Arches National Monument was established by Presidential Proclamation No. 1875 on April 12, 1929. The proclamation states that the monument was established "to protect extraordinary examples of wind erosion in the form of gigantic arches, natural bridges, 'windows,' spires, balanced rocks and other unique wind-worn sandstone formations, the preservation of which is desirable because of their education and scenic value." Research has established water as the primary erosional agent, although wind plays a role.

In 1938 the monument was enlarged to include a number of historic and prehistoric cultural sites. Boundary adjustments were made on November 15, 1938; July 26, 1960; January 21, 1969; and November 12, 1971. In 1971 the designation for Arches was changed from national monument to national park and the acreage was increased to 29,708 hectares (73,379 acres). In 1999 the Lost Spring section was added to the park, increasing the total area by 1,255 hectares (3,100 acres) to 30.979 hectares (76,519 acres).

Location Southeast Utah along and north of the Colorado River in Grand County. The park is 8 kilometers (5 miles) north of Moab, Utah, 161 kilometers (100 miles) west of Grand Junction, Colorado, and 386 kilometers (240 miles) southeast of Salt Lake City, Utah. The park is accessible by major travel routes such as Interstate I-70 located 32 kilometers (20 miles) north of the park headquarters; Utah Highway 191 runs from Interstate I-70 south to Moab and accesses the park entrance road.

The area surrounding the park (Grand County) is sparsely populated with a density of two people per square mile. Tourism is currently the most important economic activity.

Elevation From approximately 1,219 meters (4,000 feet) in the canyons to 1,585 meters (5,200 feet) on the rims.

General Description Arches National Park has the largest concentration of natural stone arches in the world. Examples of developing, complete, and collapsed arches are all evident within the park's 114 square miles. Several arches are particularly noted for their outstanding size and erosional history. Landscape Arch is probably the longest natural stone arch in the world. Delicate Arch, a freestanding arch carved from what was once a freestanding fin, is internationally recognized.

The park is 26 kilometers (16 miles) from north to south and 13 kilometers (8 miles) from east to west. There are a total of 30,966 hectares (76,519 acres) of land within the legislative boundaries. The area's topography is diverse, ranging from open flats to steep-walled cliffs. The area has been greatly affected by geologic activity associated with the salt intrusions of the Paradox formation, and the landscape has been carved by the effects of wind and water and preserved by the arid climate and lack of earthquake activity. This has produced a landscape dominated by red sandstone formations such as arches, fins, balanced rocks, mesas, canyons and spires. Major topographic features are Courthouse Wash, Courthouse

Towers, The Windows Section, Salt Valley, Klondike Bluffs, Devil's Garden and the Fiery Furnace. Some of the more famous geologic structures are Landscape Arch, Delicate Arch, Tower Arch, the Marching Men, Skyline Arch, the Three Gossips, the Three Penguins, the Windows, the Parade of Elephants, Balanced Rock and the Great Wall. There are more than 1800 catalogued arches that have a span greater than one meter (3 feet).

Arches National Park is largely covered by exposed bedrock, weakly developed soils and sand dunes. The geology of Arches National Park is largely determined by the collapsed salt anticline in Salt Valley and to a lesser extent by the collapsed Moab and Cache Valley anticlines. There are ten major sedimentary formations exposed ranging in age from the Pennsylvanian Paradox formation to the Cretaceous Mancos Shale. In stratigraphic order, formations include Paradox, Honaker Trail, Cutler Group, Moenkopi, Chinle, Wingate Sandstone, Kayenta, Navajo Sandstone, Entrada, Morrison, Cedar Mountain, Dakota Sandstone and Mancos Shale. The Paradox formation of salt and gypsum evaporates is a highly plastic formation which formed salt anticlinal structures, which collapsed when ground water eroded the salt. The Navajo and Entrada Sandstones crop out over most of the park's surface, with the Entrada forming the majority of the outstanding geologic features. The cliff-forming Wingate Formation exposed along the Colorado River forms the south boundary. Together with the associated Kayenta, Chinle and Moenkopi formations, it forms impressive eight-hundred-foot cliffs.

Several areas of pictographs and petroglyphs exist within the park. Two archeological surveys have documented approximately 100 sites. Courthouse Wash Rock Art Panel is listed on the National Register of Historic Places. The panel represents the easternmost known occurrence of Barrier Canyon Style.

Physical remains of early ranching and mining pursuits as well as traces of pioneer routes exist.

The climate is arid and characterized by hot, dry summers and cool to cold winters. The average annual precipitation is 202 millimeters (7.95 inches). Mean annual temperature is 56 degrees Fahrenheit (13.3 degrees Celsius) and the extreme temperatures are -16 degrees Fahrenheit (-26.7 degrees Celsius) and 112 degrees Fahrenheit (44.4 degrees Celsius). Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor. Precipitation peaks occur in March and August. Snow falls between November and March.

Flora Previous research conducted in the area documented strong relationships between edaphic characteristics and the distribution and composition of plant communities. Loope (1977) mapped the distribution of six relatively distinct vegetation types in relation to substrate. These types include (1) shrublands dominated by blackbrush (*Coleogyne ramosissima*) on shallow (<50 cm depth), weakly developed calcareous soils formed from sandstone or sandy shales, (2) shrublands dominated by shadscale (*Atriplex confertifolia*) on shallow soils formed from shales with high clay content, (3) grasslands dominated by needle and thread grass (*Stipa comata*), Indian ricegrass (*Stipa hymenoides*), galleta grass (*Hilaria jamesii*), various species of dropseed (*Sporobolus* spp.), and cheatgrass (*Bromus tectorum*) on deep (>50 cm depth) soils where plant roots cannot reach the water table or capillary zone, (4) shrublands dominated by 4-wing

saltbush (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*) on deep sandy soils where roots seasonally access the capillary zone, (5) communities dominated by cottonwood (*Populus fremontii*), willow (*Salix* spp.), tamarisk (*Tamarix ramosissima*) and other shrubs in riparian zones where there is immediate root access to the water table, and (6) sparse woodlands dominated by pinion (*Pinus edulis*) and juniper (*Juniperus osteosperma*) on lithic soils where water availability is controlled by hydrological effects of bedrock joints and outcrops.

Other plant communities include, Garrett saltbush/mat saltbush (*Atriplex garrettii/Atriplex corrugata*), (*Artemisia frigida/Poliomintha incana/Stipa hymenoides*), snakeweed/shadscale/Mormon tea (*Gutierrezia sarothrae/Atriplex confertifolia/Ephedra viridis*), purple sage/shinnery oak/Utah juniper (*Poliomintha incana/Quercus harvardii/Juniperus osteosperma*), and greasewood/four-wing saltbush (*Sarcobatus vermiculatus/Atriplex canescens*). Scattered springs and seeps are generally composed of maidenhair fern/Jones reedgrass (*Adiantum capillus-veneris/Calamagrostis scopulorum).*

Fauna

Mammals

Major common mammals are the western pipistrel (*Pipistrellus hesperus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), whitetailed antelope ground squirrel (*Ammospermophilus leucurus*), rock squirrel (*Spermophilus variegatus*), Colorado chipmunk (*Eutamias quadrivittatus*), Apache pocket mouse (*Perognathus flavescens*), Ord kangaroo rat (*Dipodomys ordi*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), piñon mouse (*P. truei*), northern grasshopper mouse (*Onychomys leucogaster*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), blacktailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), mule deer (*Odocoilus hemionus*), desert bighorn sheep (*Ovis canadensis nelsoni*), striped skunk (*Mephitis mephitis*), ringtail (*Bassariscus astatus*) and badger (*Taxidea taxus*).

Birds

Common bird species are the mourning dove (*Zenaidura macroura*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), violet-green swallow (*Tachycineta thalassina*), ash-throated flycatcher (*Myiarchus cinerascens*), Say's phoebe (*Sayornis saya*), scrub jay (*Aphelocoma coerulescens*), common raven (*Corvus corax*), piñon jay (*Gymnorhinus cyanocephalos*), plain titmouse (*Parus inornatus*), cañon wren (*Catherpes mexicanus*), rock wren (*Salpinctes obsoletus*), loggerhead shrike (*Lanius ludovicianus*), gray vireo (*Vireo vicinior*), black-throated gray warbler (*Dendroica nigrescens*), black-throated sparrow (*Amphispiza bilineata*) and dark-eyed junco (*Junco hymenalis*), Cooper's hawk (*Accipiter cooperi*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*) and the northern harrier (*Circus cyaneus*).

Herptofauna

Common herptofauna include the red-spotted toad (*Bufo punctatus*), Woodhouse toad *(B. woodhousei*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciousus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), leopard lizard (*Gambelia wislenzenii*), side-blotched lizard *(Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis*

catenifer), common garter snake (*Pituophis catenifer*) and the midget faded rattlesnake (*Crotalus viridis concolor).*

Aquatic Features Some exotic fish species exist in Courthouse Wash and Salt Wash. The bullfrog (*Rana catesbeiana*), exotic amphibian, is firmly established in Salt Wash. Macroinvertebrates are monitored four times a year since 1997 as part of the Water Quality Monitoring Program started in 1987. ARCH boundary is adjacent to the Colorado River for approximately 16 km (10 miles). There are four Endangered fish in the Colorado River: bonytail chub (*Gila elegans*), humpback chub (*Gila cypha),* Colorado pikeminnow (*Ptychocheilus lucius)*, and razorback sucker (*Xyrauchen texanus).* Northern river otter (*Lutra canadensis*) and beaver (*Castor canadensis)* occur along the river. There is a great blue heron (*Ardea herodias*) rookery site along the river in the park.

Unique Features and Species of Special Concern
Plant Communities of Concern Riparian, River, Relict Areas, Seeps, Springs, Hanging Gardens.

Plants ARCH has a number of sensitive plant species but none are Federally classified as Threatened or Endangered. The Canyonlands desert parsley (*Lomatium latilobum*) is a sensitive endemic that probably should be listed. Although there are populations outside the park, its center of distribution is in ARCH. Other sensitive endemics include the southwestern cloakfern (*Argyrochosma limitanea* ssp. *Limitanea*), Cutler milkweed (*Asclepias cutleri*), large-seeded milkweed (*Asclepias macrosperma*), alcove bog orchid (*Habanaria zothecina),* alcove rock daisy (*Perityle specuicola),* entrada rushpink (*Lygodesmia entrada),* helleborine *(Epipactus gigantea),* Howell scorpionweed (*Phacelia howelliana),* Trotter oreoxis (*Oreoxis trotteri),* alcove death camus (*Zigadenus vaginatus),* Osterhout's cryptanth (*Cryptantha osterhoutii*), Utah bladder fern (*Cystopteris utahensis*), wing-seed stickleaf (*Mentzelia pterosperma*), roseate gilia (*Gilia roseata*), Eastwood monkeyflower (*mimulus eastwoodii*), Moab woodyaster *(Xylorhiza glabriuscula* var. *linearifolia*), and resinbush (*Vanclevia stylosa*).

Animals Birds of special concern are the Federally Threatened southwestern willow flycatcher *(Empidonax traillii extimus*), the western burrowing owl (*Athene cunicularia hypugia*), and the brown-headed cowbird (*Molothrus ater*). Arches also contains American peregrine falcon *(Falco peregrinus anatum*) territories.

ARCH has a number of sensitive bat species including long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysandodes),* and pale Townsend's big-eared bat (*Plecotus townsendii pallesoens*).

The northern river otter (*Lutra canadensis*) is a species of concern.
Amphibians of concern include the northern leopard frog (*Rana pipiens pipiens*), tiger salamander (*Ambystoma tigrinum nebulosum*), western toad (*Bufo boreas*), and the bullfrog (*Rana catesbeiana*). The bullfrog, an exotic species, successfully competes with native amphibians.

Paleontological Resources ARCH is rich in paleontological resources. Surveys have discovered many dinosaur bone and track sites. A 2000 survey of all known sites in ARCH will result in a final report.

Resource Management Concerns

Increased recreational use, trespass livestock and exotic plant species invasion are the main natural resource management concerns. Damage to cultural resources is also a concern.

Recreation Use Visitor use increased rapidly during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off-trail destroys crytobiotic soils, tramples vegetation and increases erosion.

Land Use Impacts Although uranium mining was one of the most important area economic activities from 1950-1980, it has largely dissipated due to depressed prices and the discovery of more economical sources of uranium-bearing ore in the world. Currently, the significant mineral extraction activities in the area are solution mining of salt and potash at the Texas-Gulf Mine at Potash, Utah 10 km (6 miles) southwest of the park, and exploratory drilling for oil and gas on Bureau of Land Management (BLM) lands between Canyonlands and Arches National Parks.

Trespass livestock and the subsequent grazing and trampling is a problem. A boundary fence was finally completed in 1998 but livestock still enter areas where the fence is damaged by natural causes (flash floods) or intentionally cut. ARCH is surrounded by grazing allotments managed by the BLM.

Ambient noise levels are the lowest in the country. The degree of silence one encounters in most areas of ARCH is astounding and one of its great resources. Any noise detected may be associated with wildlife activity, other visitors, or an occasional aircraft. With increased oil and gas activity and mining potential, mineral development could add significantly to noise levels. Commercial development along Highway 191 is also a concern. Monitoring and documenting background noise levels before mineral activity increases is essential.

Without lights from a nearby metropolitan area and the relatively clear air, the park's night sky resources are outstanding. Numerous visitors, particularly those from the eastern United States or urban areas comment on this resource. Commercial development along highway 191 and development in the Moab Valley have already impacted this resource.

Invasive Exotic Plant Species ARCH has about 53 exotic plants. Tamarisk *(Tamarix ramosissima*) is a problem in the riparian areas and along the river. There has been active and aggressive tamarisk management in the past ten years and many areas are recovering with great success. Cheatgrass (*Bromus tectorum*), Russian olive (*Eleagnus angustifolia*), and Russian knapweed (*Centaurea repens*) are also a problem.

BLACK CANYON OF THE GUNNISON NATIONAL PARK (BLCA)
Size 12,159 hectares (30,045 acres)

Park History and Purpose President Herbert H. Hoover established Black Canyon of the Gunnison National Monument on March 2, 1933 (Presidential Proclamation No. 2033) under provisions of the Antiquities Act (34 Stat. 225; June 8, 1906), for the purpose of "…preservation of the spectacular gorges and additional features of scenic, scientific, and educational interest..."

Lands were added to the monument in 1935, 1938, 1939, 1958, and 1984. Public Law 98-357, which authorized the 1984 park additions states, "The purpose of this Act is to establish a boundary for the Monument in order to promote, perpetuate, and preserve the character of the land and to preserve scenic and historic resources." The Act's language recognized Black Canyon as possessing "outstanding recreational opportunities and natural characteristics of high value which...contribute as an enduring resource..." The background congressional record information provided with boundary expansion legislation states, "Although the monument contains a multitude of scientific, educational, cultural, historical, and other benefits, the center of attraction to the area is, without a doubt, the viewshed."

In 1976, Public Law 94-567 designated 4,525 hectares (11,180 acres) of the monument as wilderness, pursuant to the Wilderness Act of 1964. Through enactment of P.L. 106-76 in October 1999, additional lands, including 1,790 hectares (4,423 acres) of wilderness, were added and the monument was designated Black Canyon of the Gunnison National Park. The 1999 act states "the Black Canyon of the Gunnison and adjacent upland include a variety of unique ecological, geological, scenic, historical, and wildlife components, … extensive opportunities for educational and recreational activities, … unique geological, paleontological, scientific, educational, and recreational resources; … some private land adjacent to the Black Canyon of the Gunnison National Monument has exceptional natural and scenic value that would be threatened by future development pressures…"

Black Canyon's General Management Plan (NPS 1997a) provides guidelines for future management. It identifies management actions that satisfy public needs while protecting the area's natural and cultural resources. The General Management Plan identifies the Park Purpose for Black Canyon is to provide for

- Preservation and protection of spectacular gorges and scenic values.
- Protection of natural, cultural, and scientific resources and items of educational interest.
- Educational, scientific, and interpretive opportunities.
- Preservation of the integrity and characteristics of lands designated as wilderness.
- Opportunities for public use and enjoyment of these resources in a manner that will leave them unimpaired for future generations.
- Management of monument resources as an integral part of the Gunnison River Basin.

The General Management Plan identifies the significance of Black Canyon of the Gunnison National Park as

- The park contains a diversity of plant and animal species, several of which are rare, endangered, or unique to the area. Natural resources provide an unaltered baseline from which to measure changes in regional and global conditions.
- Its position along the Gunnison River combined with its values make BLCA an integral part of ecosystem management of the Gunnison River Basin.
- The steep gradient of the Gunnison River and the depth and narrowness of the Black Canyon is a physical barrier to the migration of fish, plants, and animals. This has resulted in a diverse group of isolated biological communities that provide unique opportunities for scientific study, for example, evolution of plants and animals, impacts of migration barriers, and so on.
- The canyon is a great place for scientific discovery and environmental education. It is a living classroom providing unique insights into geology, water and wind erosion, air quality, wildlife habitat, and cultural history.

The specific management objective identified in the Black Canyon of the Gunnison National Park Resource Management Plan (NPS 1993b) for the stewardship of park natural resources are, "…to conserve the park's ecological communities, geological resources, and scenic qualities, and to the degree possible, to restore areas disturbed by past human activities to the natural condition existing before disturbance. The concept of maintaining and perpetuating ecosystems rather than protecting and preserving individual features or favored species is, and must remain, a distinguishing aspect of natural resource management."

Location Black Canyon of the Gunnison National Park is located in Colorado's Third congressional District within Montrose County. The park is located approximately 402 kilometers (250 miles) southwest of Denver, Colorado and 24 kilometers (15 miles) east of Montrose, Colorado.

Elevation Elevations vary from 1,645 meters (5,400 feet) at canyon bottom to 2,675 meters (8,775 feet) on Signal Hill.

General Description The Black Canyon is a textbook example of a superimposed stream. Canyon walls rise precipitously 610 meters (2,000 feet) or more above the Gunnison River, which roars in the canyon depths at an average gradient of 29 meters (95 feet) per mile in the park.

The Black Canyon is one of the world's foremost wild canyons. About 1.3 to 1.7 billion years ago, canyon rocks (gneiss, schist, quartz-monzonite, and granite-pegmatite) were formed far below the earth's surface. Around 60 million years ago, during the forming of the Rocky Mountains, these hard crystalline rocks were uplifted to near the earth's surface in the Gunnison uplift. From 35 to 18 million years ago, volcanic action from the West Elk and San Juan Mountains covered the area with ash, tuff, and breccia. Erosion slowly wore away these volcanic layers along with the under lying sedimentary rocks and established the course of the Gunnison River. Two million years ago, the river started

cutting into igneous and metamorphic rocks and the Black Canyon of the Gunnison was formed.

Of the park's mosaic of biotic communities found, some are representative of communities found in a broad geographical region and some are unique to Black Canyon. The canyon rims are dominated by scrub oak and pinyon-juniper forests intermixed with patches of high desert sagebrush communities. Two sizable pinyon-juniper groves exist; one on each rim at about 2,438 meters (8,000 feet). Within these groves are many large pinyons, some over 700 years old. The canyon's north-facing slopes favor the Douglas fir and Colorado blue spruce. The river bottom has a number of deciduous trees and shrubs characteristic of river strands in the region. Very few ponderosa pines are found along the river bottom where they were protected from past annual high spring flows. A small amount of riparian vegetation, as well as scattered stands of ponderosa pine, Utah juniper, and box elder, also occur along the river.

Locally, the dominant shrub species is the Gambel oak, with serviceberry ranking second, and lesser amounts of mountain mahogany. Sagebrush is found in areas of good soil, and rabbitbrush is occasionally found. Another park ecosystem is the Pinyon-Juniper Woodland.

The associated vegetational ecosystems provide habitat for wildlife including, but not limited to, river otter, mule deer, bighorn sheep, black bear, bobcat, mountain lion, elk, golden eagle, peregrine falcon, and a variety of seasonal raptors. Small mammals include porcupines, weasels, and golden-manteled ground squirrels. The canyon rim is especially important habitat for birds because of air currents and unique interactions of rock, soil, topography, and surrounding plant communities that meet at the rim to create a distinct ecotone.

Temperatures range from a low of -9°C (15^{o}F) in the winter to approximately 29°C (85°F) in the summer. Average annual precipitation is 400-508 millimeters (16 to 20 inches) and snowfall measures between 76 and 140 centimeters (30 and 55 inches). Most precipitation occurs in the form of spring and summer rains. The wind is predominantly out of the southwest with episodes of high velocity (64 to 97 kph (40 to 60 mph)). Canyon bottoms are typically 5° to 8°C (10° to 15°F) warmer than rimtops during the summer months.

Unique Features and Species of Special Concern
BLCA offers a unique and spectacular landscape. No other North American canyon combines the narrow opening, sheer walls, and startling depths. A number of unique ecological niches exist that harbor species not found in abundance or absent on surrounding lands because of topographic variation, soil development, and exposure to sun and wind.

Plants and Vegetation Communities At least four rare plants are either known or suspected including Black Canyon gila *(Gila pentstemonoides)*, hanging garden sullivantia *(Sullivantia hapemanii var. purpusii)*, *Sclerocactus glacus*, and *Penstemon retrorsus.* Unique geological conditions and semi-arid environments combine to create a

number of habitats of particular interest including seeps & springs, riparian areas, and hanging gardens.

Animals The geographic location, along with the resources it has to offer, makes BLCA attractive for a number of sensitive and rare wildlife species. The topography has attracted a significant raptor population including golden eagles, bald eagles, prairie falcons, peregrine falcons, and many migrating birds of prey. It is suspected that the southwestern willow flycatcher uses riparian features. Peregrine falcons nest on the cliffs. The Gunnison sage grouse, a recently recognized species, use the sagebrush habitats on the north boundary to meet their year-round habitat needs.

The wildlife is typical for the regional geography and elevations. Large mammals include mule deer, black bear, bobcat, elk and an occasional mountain lion. Rocky Mountain bighorn sheep were reintroduced on BLM lands west of the park in 1985 and individuals, possibly from this transplant or from historic herds, are observed in the park although no increase in sheep numbers has been detected. River otters were reintroduced at the east (upstream) boundary and are occasionally seen along the river in the park.

The upstream water impoundments have dramatically altered the historic fish population and composition. The native species of Colorado River cutthroat trout, Colorado roundtail chub, bonytail chubs, bluehead sucker, flannelmouth sucker, and other native species may be displaced by non-native rainbow and brown trout. The present excellent conditions for brown and rainbow trout have lead to the Colorado "Gold Medal Waters" fishery designation for the Gunnison River through the park and lower gorge.

Resource Management Concerns
Major natural resource issues at BLCA include:

Livestock Grazing Livestock production and irrigated farming have been a way of life since the mid-nineteenth century. The principal use of the land surrounding BLCA is the grazing of livestock. Recurring problems are developing between grazing and wildlife habitat associated with timing of seasonal grazing use, stocking levels and inadequate fencing. Lack of fencing has resulted in livestock trampling of riparian vegetation and soil compaction. Livestock grazing may be affecting Gunnison sage grouse, elk, mule deer and bighorn sheep habitat.

Exotic Plants and Animals Exotic plant species are invading both disturbed and undisturbed areas throughout Black Canyon, displacing native species. Exotic vascular plants of particular concern include cheatgrass *(Bromus tectorum),* Canada thistle *(Cirsium arvense),* bull thistle *(Cirsium vulgare),* musk thistle *(Carduus nutans),* Russian knapweed *(Centaurea repens),* spotted knapweed *(Centaurea maculosa),* hoary cress *(Cardaria draba),* common mullein *(Verbascum thapsus),* houndstongue *(Cynoglossum officinale),* and tamarisk *(Tamarix ramosissima).*

While the upstream water impoundments have increased the valuable fishing resource through the park from a sport fishery standpoint, it has also impacted native species. The native fish species of particular concern are the Colorado River cutthroat trout *(Oncorhynchus clarki pleuriticus),* Colorado roundtail chub *(Gila robusta),* flannelmouth

sucker *(Catostomus latipinnis),* and bluehead sucker *(Catostomus discobolus),* which historically occupied the Gunnison River in the vicinity of the park.

Land Use Conversion Increased near-park development is having visual and biological impacts on resources. Habitat loss as a result of adjacent land development has affected Gunnison sage grouse, elk, deer, and bighorn sheep as well as numerous other species.

Visitor Use Increasing visitor use through the 1980s and into the 1990s contributed to direct impacts to soil and vegetative resources which have had indirect effects on sensitive habitats and wildlife species.

Altered Hydrologic Regime Dam and water diversion construction upstream of the park has altered the riparian habitat, stream flow patterns, temperature regime, fish spawning habitat, fish species and fish-food organisms on the Gunnison River within the Black Canyon.

Past Fire Exclusion The natural systems within and surrounding the park have evolved with fire. The presence or absence of natural fire within a given habitat is one of the ecological factors contributing to the perpetuation of plants and animals in that habitat. Fire suppression has contributed to an alteration of plant communities found within Black Canyon.

Lack of Basic Data A great deal of baseline information about the presence or absence, abundance and distribution of park natural resources is needed to assist park managers in making informed decisions which may have effects on natural resources. Managers currently have an insufficient understanding of park ecosystems and threats.

BRYCE CANYON NATIONAL PARK (BRCA)
Size 14,502 hectares (35,835 acres)

Park History and Purpose Bryce Canyon is known internationally for its unusual scenic beauty and scientific interest and importance found in the brightly colored and towering formations of limestone, clay, and silt, which were created primarily by the water's erosive forces. The formations, which range in shades of red and white, are a brilliant contrast to the colorful lowlands east of the park and the timbered hillsides and plateaus to the west. The vast, panoramic views from within the park to the outlying valleys and canyons add an outstanding quality to the parks aesthetic values. The park also contains a rich cultural background ranging from numerous archeological sites to nationally registered historic architecture.

Bryce Canyon National Park was originally established as a National Monument in June of 1923 by Presidential Proclamation (number 1664). The purpose was to reserve certain lands within the Powell National Forest known as "Bryce Canyon" because of unusual scenic beauty, scientific interest and importance. The proclamation identified that the public interest will be promoted by reserving as much land as necessary for the proper protection as a national monument. In June of 1924 additional legislation established Utah National Park. At this time all the lands within the boundary of the original National Monument were acquired by the Federal government "for the benefit and enjoyment of the people" and were hence forth subject to the provisions of the NPS Organic Act of 1916. In February 1928 the name was changed to Bryce Canyon National Park and administration transferred to the NPS in September. During the intervening months between February and September, eleven sections of land were added to BRCA bringing the size to 5,860 hectares (14,480 acres).

President Hoover authorized a proclamation (number 1930) in January 1931 that more than doubled the park's size resulting in a new land base of 12,367 hectares (30,560 acres). This expansion extended boundaries south and west along the Paunsaugunt Plateau to include additional scenic overlooks as far south as Rainbow Point. Again in 1931, President Hoover increased the size of BRCA by presidential proclamation (number 1952). The latest expansion extended northeast to include scenic points as far north as Shakespeare Point and resulted in a land base of 35,835 acres.

The purpose and significance of BRCA is described in the enabling legislation, the General Management Plan (NPS 1987), and the Statement for Management (NPS 1993a). BRCA is best known for hoodoos, erosional features carved from the edge of the Paunsaugunt Plateau in southern Utah. Here routine events such as freeze-thaw cycles, water run-off and mineral oxidation combine in unique ways to create uncountable oddly shaped and multi-hued fins, spires, grottoes and windows from the Claron limestones.

The park's location at the top of the Grand Staircase and the clarity of the air provide visitors the opportunity to regularly experience panoramic vistas of over 161 km. (100 miles). The absence of human development and artificial light creates conditions for unimpeded distant views by day and unparalleled viewing of the brilliant night skies. In conjunction with both public and private lands the park provides the unique opportunity for visitors from around the world to observe wildlife in the peaceful settings of three

forest community types (pinyon/juniper, ponderosa pine or a fir/spruce/aspen mixed). A diverse range of recreational opportunities provide visitors an understanding of the park's role in the area's cultural history.

Location Bryce Canyon National Park is located approximately 129 kilometers (80 miles) northeast of Cedar City, Utah on the Paunsaugunt Plateau.

Elevation Elevation ranges from approximately 1,859 meters (6,100 feet) in the eastern lowlands to 2438 meters (8,000 feet) at headquarters to 2,774 meters (9,100 feet) at the park's southern end. Annual precipitation averages 381 millimeters (15 inches) with an average annual snowfall of 254 centimeters (100 inches) at headquarters.

General Description BRCA is a long, roughly rectangular-shaped area located on the Paunsaugunt Plateau's eastern rim. The Paunsaugunt Plateau is situated on the southwest edge of the Colorado Plateau at the head of the Paria River. The Paunsaugunt is an upthrust fault block forming the highest step of the Grand Staircase along the north side of the Colorado River. The fault forming the east scarp of the Paunsaugunt exposes the Pink Cliffs, a series of spectacular formations of Cretaceous age limestone, sandstone, and shale of varied color and form. The deeply eroded cliffs form a series of fourteen canyons/amphitheaters along the rim. Above the escarpment, the plateau dips gently to the west draining surface runoff in to the East Fork of the Sevier River. Plateau vegetation ranges from ponderosa pine forests in the north to dense mixed conifer forests in the south. The forests are interspersed with a dozen or more mountain meadows dominated by late seral sagebrush communities. Greenleaf manzanita is very abundant in forest areas with low tree stem density. Aspen is sparse at the southern end. All stands are heavily encroached by conifer and are currently very small in size. Below the rim, ponderosa pine, Utah juniper, and pinyon pine dominate the overstory vegetation. A few cottonwood trees are found along streams fed by small springs at the base of the Pink Cliffs.

Flora Vegetation communities can be categorized in to six groups: subalpine open and semi moist meadows; fir-spruce-aspen forests; high plateau sagebrush; ponderosa pine forest; pinyon-juniper woodland; and The Breaks. The amount of soil moisture present is the most important factor in the extent and profusion of flowering plants associated with each plant community. There are endemic plant species. However, there are a number of species on the fringe of their distribution and thus considered rare in this area. The park supports an estimated 522 plant species (Foster 1995). New species are discovered periodically.

Fauna Fauna is typical of Colorado Plateau species. Approximately 290 species of amphibian, reptile, bird and mammal species have been observed. Amphibians are rarely observed but are found in selected locations near water. The short-horned lizard and the desert whiptail are the most common reptiles seen. Visitors in the breaks periodically observe the Great Basin rattlesnake. Common bird species on the plateau include common ravens, Steller's jays, dark-eyed junco, and mountain chickadees.
Below the rim, swallows of several species, swifts and scrub jays are regularly observed. The red-tailed hawk is the most common raptor. Mule deer, golden-mantled ground squirrel, and Unita chipmunk are the most common mammals observed. Utah prairie

dogs are found in most mountain meadow habitats. Visible signs of mountain lion and black bear are regularly found but these species are observed infrequently.

Aquatic Features BRCA's location along the Paunsagunt Fault provides a unique opportunity for springs to surface as ground water encounters the Tropic Shale Formation. Thirty-three springs have been located, of which twenty have sufficient flow to measure (Ott 1996). Few streams actually carry surface water year round. The ones that do are extremely small during portions of the year.

Unique Features and Species of Special Concern
Hoodoos Rock spires left behind by erosional forces of wind and water along the plateau's eastern edge.

Utah prairie dogs Utah prairie dogs are listed as threatened species under the Endangered Species Act. Numbers have fluctuated between 45 and 225 since they were re-introduced in 1975.

Rare plants Currently there are 23 taxa considered sensitive These include Ward milkvetch (*Astragalus wardii*), Reveal Indian paintbrush* (*Castilleja parvula* var. *revealii*), yellow-white catseye* (*Cryptantha ochroleuca*), Cedar Breaks biscuitroot (*Cymopterus minimus*), Abajo daisy (*Erigeron abajoensis*), Jones' gentian (*Gentianella tortuosa*), Cedar Breaks goldenbush (*Haplopappus zionis*); Jones golden-aster (*Heterotheca jonesii*), king's ivesia (*Ivesia kingii*), intermountain ivesia (*Ivesia sabulosa*), Bryce bladderpod *(Lesquerella rubicundula*), little desert parsely (*Lomatium minimum*), Jones' locoweed (*Oxytropis oreophilla* var. *jonesii*), Paria breadroot* (*Pediomelum pariense*), Red Canyon phlox (*Phlox gladiformis*), Red Canyon beardtongue* (*Penstemon bracteatus*), Markagunt beardtongue (*Penstemon leiophyllus* var. *leiophyllus*, lepidota twinpod (*Physaria chambersii* var. *membranacea*), podunk groundsel (*Senecio malmstenii*), Peterson catchfly* (*Silene petersonii*), Wyoming rock-tansy (*Sphaeromeria capitata*) and least townsendia (*Townsendia minima*).

Most of these plants occur in the unique "breaks" community environment. Populations of plants indicated with an asterisk have been monitored over time and seem little affected by the current level and location of tourism activities. More surveys are needed within remote areas to determine the extent of each rare plant species. These surveys will also look for new occurrences of rare plants found in similar habitats outside the park boundary.

Bald Eagles and California Condors Periodic observations of bald eagles and California condors have been recorded. These two species are protected under the Endangered Species Act but have never been observed nesting at BRCA.

Bristlecone Pine The Bryce Canyon Breaks is the lowest elevation site in the distribution of this species.

Aspen Aspen clones have slowly become decadent as their habitat is encroached by conifers through natural succession. Fire suppression actions have removed a source of disturbance that would have resulted in regeneration of aspen at the south end.

Resource Management Concerns
Human landscape impacts have seriously diminished many Bryce Canyon resources and natural processes. Plant communities in some locations have been heavily trampled, and in other areas they have changed dramatically due to aggressive fire suppression activities at the turn of the 20th century. The park has focused on meeting visitor needs at the expense of basic prevention and correction of resource deterioration, quantitative resource inventorying and monitoring, and planning for mitigation/restoration actions. Past total fire suppression policies have caused significant changes to plant communities resulting in unnatural species abundance and an altered assemblage of species diversity.

The threatened Utah prairie dog has colonized most mountain meadow habitats and in some cases can be found in close proximity to human developments. A conservation strategy is currently being pursued to protect this threatened species and public safety.

Recreation Use Annual visitation since 1980 has significantly increased. The annual average rate of increase in visitation was 7.5 %. Parking turnouts along the Rim Road provide many opportunities for visitors to enjoy scenic vistas. Annual visitation to BRCA reached a peak of 1.7 million visitors in 1996, with only slightly lower visitation rates since.

Visitation is primarily concentrated within the 252-acre developed area. Most visitors never go south of the main amphitheater, and average visitation time is less than a half day. Consequently, very high visitor density in the main amphitheater area has resulted in trampling of vegetation, heavy social trailing, wildlife attracted to human food sources, and individual deer and rodents very habituated to human activities that could become a threat to visitor safety. A small portion of recreational use includes backcountry hiking and overnight camping.

Land Use Impacts Cattle and sheep grazing was one of the earliest known human impacts on the land. Grazing was well established from Mormon settlement in the l870s. Grazing on the plateau occurred during the summer months while ranchers moved their stock to lower elevations in winter. The Forest Service issued grazing permits from 1903 until 1929. Leniency toward resource stewardship and forage consumption was general practice (Buchanan 1960). From 1907 to 1940, forage abundance in declined "inexorably" (Scrattish 1985).

Timber harvesting in the area of the park began in the late 1800s and by 1890 a sawmill was located in the park's northeast portion. Harvesting occurred in Henderson Canyon. The mill was moved to the mouth of Bryce Canyon. By 1896 another sawmill was constructed in Dave's Hollow west of the present headquarters building. No conservation measures were implemented. This mill specialized in fine finished lumber, much of which was shipped to Salt Lake City. Harvesting occurred throughout the park's northern portion.

In 1889, a stock company was organized in Tropic to divert water from the East Fork of the Sevier River to the Paria River Valley to irrigate fields. The Tropic Ditch now diverts water through 15 kilometers (9 miles) of canal and over the rim into Water Canyon. The

ditch opens an avenue for aquatic life to migrate from the Great Basin to the Colorado River Basin.

Exotic Plant Species There are 61 exotic plant species known in BRCA; most populations are small. Systematic surveys were begun in 1998 to identify and quantify exotic plant populations. While the survey is not complete, areas with the highest probability of invasion have been surveyed. The species of most concern include musk thistle (*Carduus nutans)*, Canada thistle *(Circium arvense)*, Russian thistle *(Salsola iberica)*, mullein *(Verbascum thapsus)*, and cheatgrass (*Bromus tectorum)*.

CANYONLANDS NATIONAL PARK (CANY)
Size 136,610 hectares (337,570 acres)

Park History and Purpose Efforts to turn Utah's canyon country into a national park began about 1935 when Secretary of the Interior Harold Ickes proposed setting aside 7,000 square miles of southeast Utah as Escalante National Monument. This effort was doomed by opposition from state commercial interests and the demands of World War II (Smith 1991), but with the rise of the conservation movement in the 1960s, Senator Frank Moss, Secretary of the Interior Stewart Udall, and locals such as Kent Frost took up the battle to preserve the "still untouched" canyon country near the confluence of the Green and Colorado Rivers. Their efforts resulted in Congress and President Lyndon B. Johnson setting aside Canyonlands National Park on September 12, 1964. As stated in Public Law 88-590, Canyonlands was established "...to preserve an area in the State of Utah possessing superlative scenic, scientific, and archeological features for the inspiration, benefit, and use of the public..." This is the overriding legal mandate that guides the park's resource management program today.

Location Canyonlands National Park is located in southeast Utah along the Colorado and Green Rivers in Grand, Garfield, San Juan and Wayne Counties. The park is southwest of Moab, Utah, 161 kilometers (100 miles) west of Grand Junction, Colorado, and 386 kilometers (240 miles) southeast of Salt Lake City, Utah. Parts of the park are readily accessible by major travel routes such as Interstate I-70 and Utah Highway 191.

The area surrounding the park is sparsely populated with a density of approximately two people per square mile (0.8 people per square kilometer). Tourism is currently the most important economic activity.

Elevation Elevations range from approximately 1,189 meters (3,900 feet) on the Colorado River south of Cataract Canyon to 2,188 meters (7,180 feet) above Big Pocket in the Needles District.

General Description Canyonlands National Park has been expanded since originally established in 1964 to its present size of 136,610 hectares (337,570 acres) centered around the confluence of the Green and Colorado Rivers. The rivers divide the park into three geographical districts: the Island in the Sky District is the triangle of land between the two rivers, the Needles District lies east of the Colorado River, and the Maze District lies to the west of the Colorado and Green Rivers. The Horseshoe Canyon Detached Unit is managed as part of the Maze District. In addition, the Green and Colorado River corridors are managed as a separate River District.

From prehistoric Native Americans searching for chert outcrops, through the geological investigations of John Wesley Powell and other turn-of-the-century explorers, to uranium miners of the 1950s, the geologic resources of Canyonlands have been of major interest and importance. As a result geological publications are widely available (Baars and Molenaar 1971; Huntoon, Billingsley and Breed 1982; Mutschler 1969) and the park's geological resources are well known.

For visitors, probably the two most important geological features are the uniquely banded red and white sandstone of the Cedar Mesa formation (exposed in the Needles and Maze Districts) and the White Rim Sandstone exposed in the Island in the Sky District.

Incredible features include the remote mesas, buttes, and deep canyons cut by the Green and Colorado Rivers and their tributaries. The park's name, Canyonlands, is derived from the geology term "Canyon Lands," which is defined as the province south of the Uinta Basin and between the High Plateaus on the west and the Rocky Mountains to the east. As explained by Stokes (1988:241), the park lies at the rugged and remote heart of the Canyon Lands section of the Colorado Plateau physiographic province in southeast Utah. The park is characterized by sedimentary rock, which has been deformed by anticlines, synclines and monoclines. Uplift of the Colorado Plateau and concurrent water erosion have produced the extensive, deep canyon systems which are the defining features and of park and physiographic section (Lammers 1991).

There are five major sedimentary formations exposed ranging in age from the Pennsylvanian Paradox formation to the Jurassic Navajo Sandstone. In stratigraphic order, formations include Paradox, Honaker Trail, Cutler Group, Moenkopi, Chinle, Wingate Sandstone, Kayenta, and Navajo Sandstone. The Paradox formation of salt and gypsum evaporates is a highly plastic formation which has formed the salt anticlinal structures and grabens, which collapsed when ground water eroded the salt.

The climate is arid; characterized by hot, dry summers and cool to cold winters. Temperatures vary with altitude and latitude (Brough, Jones and Stevens 1987). In the Needles District at an elevation of 1,536 meters (5,040 feet) the average maximum temperature is 68.3^0 F, the average minimum is 37.8^0 F. The average annual precipitation is 219 millimeters (8.62 inches). In the Island in the Sky at an elevation of 1,807 meters (5,930 feet) the average maximum temperature is 64.1^0 F, and the average minimum temperature was 42.2^0 F. Temperatures can reach as high as 110^0 F and as low as -16^0 F. The normal annual precipitation is 235 millimeters (9.27 inches).

Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor. Precipitation peaks occur in March and August. Snow falls between November and March.

Flora Previous research documented strong relationships between edaphic characteristics and the distribution and composition of plant communities. Loope (1977) mapped the distribution of six relatively distinct vegetation types in relation to substrate. These types include (1) shrublands dominated by blackbrush (*Coleogyne ramosissima*) on shallow (<50 cm depth), weakly developed calcareous soils formed from sandstone or sandy shales, (2) shrublands dominated by shadscale (*Atriplex confertifolia*) on shallow soils formed from shales with high clay content, (3) grasslands dominated by needle and thread grass (*Stipa comata*), indian ricegrass (*Stipa hymenoides*), galleta grass (*Hilaria jamesii*), various species of dropseed (*Sporobolus* spp.), and cheatgrass (*Bromus tectorum*) on deep (>50 cm depth) soils where plant roots cannot reach the water table or capillary zone, (4) shrublands dominated by 4-wing saltbush (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*) on deep sandy soils where roots seasonally access the capillary zone, (5) communities dominated by cottonwood (*Populus fremontii*), willow

(*Salix* spp.), tamarisk (*Tamarix ramosissima*) and other shrubs in riparian zones where there is immediate root access to the water table, and (6) sparse woodlands dominated by pinyon (*Pinus edulis*) and juniper (*Juniperus osteosperma*) on lithic soils where water availability is controlled by hydrological effects of bedrock joints and outcrops.

Other plant communities include snakeweed/shadscale/Mormon tea (*Gutierrezia sarothrae/Atriplex confertifolia/Ephedra viridis*), purple sage/shinnery oak/Utah juniper (*Poliomintha incana/Quercus harvardii/Juniperus osteosperma*), and greasewood/four-wing saltbush (*Sarcobatus vermiculatus/Atriplex canescens*). Springs and seeps are also scattered throughout the park and are generally composed of maidenhair fern/Jones reedgrass (*Adiantum capillus-veneris/Calamagrostis scopulorum).*

There are a number of small communities scattered in unique microsites. These include relictual Douglas fir (*Pseudotsuga mensezii*) and aspen (*Populus tremuloides*) sites.

Fauna

Mammals

CANY is extremely important habitat for desert bighorn sheep (*Ovis canadensis nelsonii*). Additional mammals include the western pipistrel (*Pipistrellus hesperus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), white-tailed antelope ground squirrel (*Ammospermophilus leucurus*), rock squirrel (*Spermophilus variegatus*), Colorado chipmunk (*Eutamias quadrivittatus*), Apache pocket mouse (*Perognathus flavescens*), Ord kangaroo rat (*Dipodomys ordi*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), piñon mouse (*P. truei*), northern grasshopper mouse (*Onychomys leucogaster*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), blacktailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), mule deer (*Odocoilus hemionus*), striped skunk (*Mephitis mephitis*), ringtail (*Bassariscus astatus*) and badger (*Taxidea taxus*).

Birds

Common bird species are the mourning dove (*Zenaidura macroura*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), violet-green swallow (*Tachycineta thalassina*), ash-throated flycatcher (*Myiarchus cinerascens*), Say's phoebe (*Sayornis saya*), scrub jay (*Aphelocoma coerulescens*), common raven (*Corvus corax*), piñon jay (*Gymnorhinus cyanocephalos*), plain titmouse (*Parus inornatus*), cañon wren (*Catherpes mexicanus*), rock wren (*Salpinctes obsoletus*), loggerhead shrike (*Lanius ludovicianus*), gray vireo (*Vireo vicinior*), black-throated gray warbler (*Dendroica nigrescens*), black-throated sparrow (*Amphispiza bilineata*) and dark-eyed junco (*Junco hymenalis*), Cooper's hawk (*Accipiter cooperi*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*) and the northern harrier (*Circus cyaneus*).

Herptofauna

Common herptofauna are the red-spotted toad (*Bufo punctatus*), Woodhouse toad *(B. woodhousei*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciousus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), leopard lizard (*Gambelia wislenzenii*), side-blotched lizard

(Uta stansburiana), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis catenifer*), common garter snake (*Pituophis catenifer*) and the midget faded rattlesnake (*Crotalus viridis concolor).*

Aquatic Macroinvertebrates are monitored four times a year, since 1997, as part of the Water Quality Monitoring Program started in 1987. There are four endangered fish in the Colorado and Green Rivers: bonytail chub (*Gila elegans),* humpback chub (*Gila cypha),* Colorado pikeminnow (*Ptychocheilus lucius),* and razorback sucker (*Xyrauchen texanus).* We also have northern river otter (*Lutra canadensis*) and beaver (*Castor canadensis*).

Unique Features and Species of Special Concern
Plant Communities of Concern Riparian, River, Relict Areas, Seeps, Springs, Hanging Gardens, Douglas fir (*Pseudotsuga menziesii*) relict areas, and Aspen (*Populus tremuloides*) relict areas.

Plants CANY has a number of sensitive plant species but none are Federally classified as Threatened or Endangered. Sensitive endemics include the southwestern cloakfern (*Argyrochosma limitanea* spp. *Limitanea*), large-seeded milkweed (*Asclepias macrosperma*), Rusby milkweed (*Asclepias rusbyi*), bird's nest milkvetch (*Astragalus nidularius*), Fisher milkvetch (*Astragalus piscator*), sandstone milkvetch (*Astragalus sesquiflorus*), Franklin's ceonothus (*Ceonothus greggii* var. *franklinii*), Cateract gilia (*Gilia latifolia* var. *imperialis*), Hutchin's gilia (*Gilia hutchinsonfolia*), rimrock phlox (*Phlox austromontana* var. *lutescens*), alcove bog orchid (*Habanaria zothecina),* Jane's globemallow (*Sphaeralcea janae*), resinbush (*Vanclevia stylosa*), alcove rock daisy (*Perityle specuicola),* entrada rushpink (*Lygodesmia entrada),* helleborine *(Epipactus gigantea),* Howell scorpionweed (*Phacelia howelliana),* Trotter oreoxis (*Oreoxis trotteri),* alcove death camus (*Zigadenus vaginatus),* Osterhout's cryptanth (*Cryptantha osterhoutii*), Utah bladder fern (*Cystopteris utahensis*), wing-seed stickleaf (Mentzelia pterosperma), roseate gilia (*Gilia roseata*), Eastwood monkeyflower (*mimulus eastwoodii*), Moab woodyaster *(Xylorhiza glabriuscula* var. *linearifolia*), San Rafael prickly pear (*Argemone corymbosa* ssp. a*renicola*), and Toft's yucca (*Yucca angustissima* var. *toftiae*).

Animals The park has five Federally listed Endangered species, four are fish: Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*) and bonytail chub (*Gila elegans*). The fifth is the southwestern willow flycatcher (*Empidonax trailii extimus*). Surveys just completed observed this species, but no breeding sites were found (Johnson et al.1999).

The bald eagle (*Haliaeetus leucocephalus*) and the American peregrine falcon (*Falco peregrinus anatum*) have recently been delisted. One park species listed as Threatened is the Mexican spotted owl (*Strix occidentalis lucida*). Extensive inventories reveal a number of breeding Mexican spotted owls (Willey 1998). Some monitoring for peregrine falcons and bald eagles has occurred, but more thorough and regular surveys are needed. The bald eagle uses the park primarily for winter forage. Two other birds of concern are the Western burrowing owl (*Athene cunicularia hypugia*) and the brown-headed cowbird (*Molothrus ater*).

CANY has a number of sensitive bat species including long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysandodes),* and pale Townsend's big-eared bat (*Plecotus townsendii pallesoens*).

The northern river otter (*Lutra canadensis*) is a species of concern.

Amphibians of concern include the northern leopard frog (*Rana pipiens pipiens*), tiger salamander (*Ambystoma tigrinum nebulosum*), western toad (*Bufo boreas*), and the bullfrog (*Rana catesbeiana*). The bullfrog, an exotic, competes successfully with native amphibians.

Resource Management Concerns
Increased recreational use (visitation) and exotic plant species invasion are the main natural resource management concerns. Damage to cultural resources is also a concern.

Recreation Use Visitor use increased rapidly during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off-trail destroy crytobiotic soils, tramples vegetation, increases erosion, and effects plant growth.

Land Use Impacts Although uranium mining was one of the most important area economic activities from 1950-1980, it has largely dissipated due to depressed prices and the discovery of more economical sources of uranium-bearing ore in the world. Currently, the significant mineral extraction activities are solution mining of salt and potash at the Texas-Gulf Mine at Potash, Utah north of the park, and exploratory drilling for oil and gas on adjacent BLM lands.

Ambient noise levels are the lowest in the country. The degree of silence one encounters in most areas of CANY is astounding and one of its great resources. Any noise detected may be associated with wildlife activity, backcountry hikers or an occasional aircraft. Increased oil and gas activity and the potential for mining could add significantly to noise levels. Commercial enterprises, such as airplane sightseeing tours, could also have an impact.

Without lights from a nearby metropolitan area and the clearest air in the country, the night sky resources are outstanding. Located on a plateau, one has a nearly 360 degree view of the stars. Numerous visitors, particularly those from the eastern United States or urban areas comment on this resource. Commercial development along highway 191 and development in the Moab Valley have already impacted this resource.

Invasive Exotic Plant Species
CANY has about 60 exotic plants. Tamarisk *(Tamarix ramosissima*) is a problem in riparian areas and along the river. Cheatgrass (*Bromus tectorum*), Russian olive (*Eleagnus angustifolia*), and Russian knapweed (*Centaurea repens*) are also a problem. There is a full time vegetation specialist and progress is being made mapping and eliminating many exotic plant sites.

CAPITOL REEF NATIONAL PARK (CARE)
Size 97,895 hectares (241,904 acres)

Park History and Purpose Capitol Reef was first established as a National Monument by Franklin D. Roosevelt on August 2, 1937 by Presidential Proclamation 2246 (50 Stat. 1856). The Proclamation stated that the Monument's purpose was to reserve in the public interest "narrow canyons displaying evidence of ancient sand dune deposits of unusual scientific value, and ...various other objects of geological and scientific interest." The monument originally comprised 14,998 hectares (37,060 acres).

The monument was enlarged by Dwight D. Eisenhower through Presidential Proclamation 3249 of July 2, 1958, 3 C.F.R. 160, which added "certain adjoining lands needed for the protection of the features of geological and scientific interest," bringing the total acreage to 40,100.

On January 20, 1969, Lyndon B. Johnson signed Presidential Proclamation 3888, 3 C.F.R. 387, which enlarged Monument boundaries six-fold to encompass 103,259 hectares (255,156 acres). This expansion was to add "certain adjoining lands which encompass the outstanding geological feature known as Waterpocket Fold and other complementing geological features, which constitute objects of scientific interest, such as Cathedral Valley."

On December 18, 1971, Congress abolished Capitol Reef National Monument and established Capitol Reef National Park, with its final boundaries encompassing 97,895 hectares (241,904 acres) (85 Stat. 639, 16 U.S.C. § 273 *et seq*.). This Act made provisions for land acquisition, management of grazing privileges, and trailing and watering regulations.

The General Management Plan (NPS 1998) describes the purpose and significance for Capitol Reef National Park derived from its enabling legislation as

- conserving and protecting such geologic wonders as the Waterpocket Fold, Cathedral Valley, narrow canyons, and evidence of ancient sand dune deposits, and objects of geologic and scientific interest; and
- protecting all park features from unauthorized appropriation, injury, destruction, or removal.

The General Management Plan further recognizes that "the park preserves a variety of habitat types that support diverse plant and animal life."

Location CARE is located in south central Utah within portions of Emery, Garfield, Sevier, and Wayne Counties. It is a high-elevation, cold desert park lying in the northern portion of the Colorado Plateau. It is 112 kilometers (70 miles) long and varies from 2 to 23 kilometers (1 to 14 miles) wide. It is 119 kilometers (74 miles) by road east of Richfield, Utah and 290 kilometers (180 miles) southwest of Grand Junction, Colorado.

Elevation Elevation varies from 2,731 meters (8,960 feet) on Thousand Lake Mountain in the northwest section to 1,183 meters (3,880 feet) in Halls Creek at the southern tip.

General Description CARE encompasses most of the 161 kilometer-long (100-mile) Waterpocket Fold, the largest exposed monocline in North America. The Waterpocket Fold formed 65 to 80 million years ago and consists of a geological uplift that stretches from Thousand Lake Mountain in the north to Lake Powell in the south. The park is named for this formation and some of its features. “Capitol” comes from the white sandstone domes that tower over the Fremont River and resemble the U.S. Capitol Rotunda, and “Reef” comes from the seafaring term for obstacles to navigation. A second noted feature is Cathedral Valley, a flat valley punctuated with sheer sandstone spires and fins.

CARE is situated on a slope that drops rapidly in elevation from west to east. Over a distance of 24 kilometers (15 miles), 11,000 foot-high mountains just west of the park drop to 1,219 meter (4,000 feet) high valleys to the east. The Waterpocket Fold is deeply cut along its length with west-to-east flowing canyons, the largest of which contains the Fremont River. Between the canyons are undulating sandstone domes or tilted slickrock plates. Two north-south oriented valleys are present on the eastern side, in geologic terms, strike valleys. They are less than a mile wide and are bounded by the Waterpocket Fold on the west and steep cliffs on the east. The dramatic scenery of Capitol Reef is the result of erosion of various rock layers during more recent geologic time.

Nearly 10,000 vertical feet of sedimentary rocks are exposed in and around Capitol Reef. Seventeen identified geologic formations (Billingsley et al. 1987) were originally deposited about 270 to 65 million years ago, under conditions varying from dry sand dunes to marine swamps. More recent volcanic activity formed lava dikes and sills in the northern end. Debris flows from Boulder and Thousand Lake Mountains deposited volcanic boulders on top of the sedimentary formations through the northern and middle sections.

The complex terrain and the natural processes that predominate at Capitol Reef combine to provide diverse habitats for plants and animals. The parklands support a patchwork of terrain, life zones, and habitats, where even slightly different combinations of slope, aspect, exposure, elevation, moisture, mineral content, and other variables blend to create distinctive microclimates and narrow niches. As a result, many sensitive desert species that require specific conditions—and which cannot survive outside of those parameters—occupy niches at Capitol Reef (NPS 1998). The Waterpocket Fold is home to numerous threatened, endangered, and rare species, as well as endemic plant species. This is one of the greatest concentrations in the region of plant taxa of special concern. The high plant diversity in CARE reflects the great range of habitats present and the geographic location at the intersection of several biogeographic regions (Heil et al. 1993).

Flora CARE supports a diverse floristic assemblage with over 900 vascular plant taxa documented. Dominant vegetation communities are typical of the Colorado Plateau Physiographic Province with pinyon-juniper woodland, grassland, and upland shrub communities present. Thirty-four plant communities have been identified, with 11 being unique or first described here. Distribution of communities is controlled primarily by gradients in elevation and geologic substrate. Dry, hot areas at the lowest elevations support various upland shrub, grassland, and badlands communities; sandstones at low

elevations and a variety of substrates at middle elevations support several kinds of pinyon-juniper communities; and cool, moist sites at high elevations are covered by woodland communities dominated by conifers or aspen. Riparian areas at all elevations support woodlands and wetlands (Heil et al. 1993).

Past livestock grazing has altered the composition and structure of many grassland and riparian communities in CARE. It may require many decades of grazing protection and possibly active intervention to restore these communities to their presettlement condition. Recovery of community structure probably will be more rapid in riparian areas than in grasslands, but restoration of original species composition may be slow in both areas. Establishment during the 20th century of exotic plants, e.g., tamarix (*Tamarix chinensis*) and cheatgrass (*Bromus tectorum*) has permanently changed the composition of many plant communities in CARE (Heil et al. 1993). Although plant communities have been described, no vegetation map has been completed.

Fauna There are over 300 species of mammals, birds, reptiles, amphibians, and fish found in CARE. Common mammals include mule deer, yellow-bellied marmots, bighorn sheep, and coyotes. Birds are most numerous in cottonwood and willow vegetation along streams and perennial water sources. Reptiles occur throughout the park. The most common lizards are the side-blotched and sagebrush lizards and the most common snakes are gopher snake and striped whipsnake. Amphibians are not common, being found only near streams, springs, and rock pools. Native and introduced fish species are found in Fremont River and Pleasant, Halls, Oak, and Sulphur Creeks.

Aquatic Features CARE has six perennial streams and many tinajas, which give the Waterpocket Fold its name. Tinajas are inventoried for the southern portion but not the northern. Several native and introduced fish species are found in the Fremont River and Pleasant, Halls, Oak, and Sulphur Creeks. Macroinvertebrates have been examined in a couple localities and several new species have been described. Water rights have not been adjudicated for this basin, but the park has numerous primary rights used to irrigate historic orchards and fields.

Unique Features and Species of Special Concern

Vegetation Communities Four plant communities are of special concern because they are unique to the park, are vulnerable to disturbance, and/or are rare throughout their range. These include 1) bristlecone pine (*Pinus longaeva)*-cushion plant community which is very restricted in distribution, has very old trees, and contains several rare, endemic plant species; 2) waterpocket community (*Acer negundo, Populus fremontii*, and *Salix exigua*), which is restricted in distribution and provides value to wildlife far greater than its limited occurrence; 3) hanging garden community which is rare and fragmented in its distribution and contains several endemic plant species; and 4) hornbeam (*Ostrya knowltonii*)-boxelder (*Acer negundo*)-oak (*Quercus gambelii*) woodland is restricted to a few localities in the southern end.

Plants CARE contains populations of eight of the 20 Federally listed plant species that occur in Utah. For several of the 24 NPS designated sensitive plant species, there are fewer than 5,000 individual plants known, and these are found primarily in Capitol Reef. This large number is primarily due to the diverse geology and topography and extensive

endemism in the flora. Numerous geologic formations (each with its own range of soil moisture, soil chemistry, texture, and mineral composition) occur in narrow bands and at various elevation. This great variety of small habitats and unique growing conditions provides niches for a large number of plant species with limited ranges.

Animals CARE supports populations of 4 Federally listed animal species and 9 species considered sensitive by the NPS. The listed species are bald eagle (*Haliaeetus leucocephalus)* which is a winter resident; Mexican spotted owl (*Strix occidentalis lucida*) with up to 14 known nesting sites; southwest willow flycatcher (*Empidonax traillii extimus*) - status unknown; and Utah prairie dog (*Cynomys parvidens*) which is extirpated from the park. Sensitive animal species include 3 birds, 2 mammals, 1 reptile, 1 amphibian, and 2 fish.

Resource Management Concerns

Livestock grazing A total of 1,380 Animal Unit Months (AUMs) of winter cattle grazing is permitted on 35,208 (87,000 acres) in the northern and central portions. Park resources (including flora, fauna and physical resources) are impacted by the direct and indirect effects of livestock grazing including displacement of native plant species by invasive exotic species; direct impacts to populations of rare plant species; and conversion of native plant communities. Grazing has been reduced 72% in the park since 1988 by reallocation of AUMs to areas outside the park and from willing-seller buyouts of grazing permits. Acquisition of AUMs on a willing-seller basis will continue as opportunities arise. However, because the park currently is legally obligated to provide grazing and trailing, other options for reducing domestic livestock grazing are not available. Additional grazing impacts are occurring from a herd of non-native bison introduced in the 1940s for hunting on adjacent public lands. The animals escape hunting pressure by entering the park and are creating intensive impacts in localized areas. Inventories of all taxa, especially sensitive species, are needed to properly evaluate the effects of grazing.

Recreation Use Visitor use increased rapidly during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off-trail destroy crytobiotic soils and tramples vegetation, which accelerates erosion. Unfortunately, many of these areas contained rare plant species, some of which could become listed if plants in those localities disappear because of these impacts. Inventories have been done in the heavily used areas around headquarters but additional work has not been done evaluate other localities.

Land Use Impacts Agricultural practices, both upstream and within the historic district, continue to modify stream flows and increase nutrient loads in the Fremont River and Sulphur Creek. Water rights adjudication has not been completed for these streams, therefore instream flows are not guaranteed. A two-year project to inventory fish and stream habitats for the Fremont River is available through Regional Natural Resource funds.

Endemic Plant Species The large number of listed and very rare plant species increases the difficulty in evaluating effects of any management actions and creates an additional

burden for law enforcement to monitor at-risk populations. The previously mentioned impacts are identified in recovery plans as threats to rare species and, in recent years, collection of rare plant species has increased dramatically. Several populations of listed species on park and adjacent BLM lands have been decimated by commercial collecting operations, and unscrupulous collectors are offering park plants for sale on the Internet. Because the park has only three patrol rangers for such a large area, all commercially valuable cultural and natural resources, including rare plants, are systematically looted each year with little chance of perpetrators being caught. We currently have an NRPP-funded three-year project to inventory all rare plants in the park. Using information from previous limited surveys, we are monitoring visitor and cattle impacts to several species. Once the park-wide survey is complete, monitoring would be expanded to include these species.

Invasive Exotic Plant Species There are 108 exotic plant species that occur within CARE. The majority are present in the Fruita orchards but five main problem species occur throughout the park. Tamarisk (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*) are the primary invasives in riparian habitats along streams and washes. The Fremont River is the most heavily infested area and very little control efforts to date. The tree-of-heaven (*Ailanthus altissima)* is very dense locally in the Fruita and Sleeping Rainbow ranch areas and is being treated with moderate success. As a result of overgrazing, *Halogeton* (*Halogeton glomeratus*) and cheatgrass (*Bromus tectorum*) are the primary invaders in upland areas. *Halogeton* appears to be concentrated in the northern part of the park and cheatgrass is densest in the southern. Only the *Ailanthus* has been adequately mapped to be able to prioritize control efforts.

CEDAR BREAKS NATIONAL PARK (CEBR)
Size 2,491 hectares (6,155 acres)

Park History and Purpose Cedar Breaks National Monument was established by President Franklin D. Roosevelt by Proclamation No. 2054 on August 22, 1933, under authority of the Act of Congress approved June 8, 1906 (34 Stat. 225), known as an Act for the Preservation of American Antiquities, and the Act of June 4, 1897 (30 Stat. 34). The Proclamation states that "it appears desirable, in the public interest to...include said lands within a National Monument for the preservation of spectacular cliffs, canyons, and features of scenic, scientific, and educational interest contained therein..." Cedar Breaks National Monument is administered by Zion National Park, which is located approximately 64 kilometers (40 miles) to the south.

The proclamation establishing the monument and the Organic Act of 1916 establishing the National Park Service direct the basic principles and objectives for the management of park resources. The proclamation describes Cedar Breaks as "spectacular" and mandates the preservation of its "features of scenic, scientific, and educational interest..." The Organic Act (39 Stat. 535) states that, "the fundamental purpose of the said parks, monuments and reservations...is to conserve the scenery and natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Cedar Breaks National Monument Strategic Plan for FY2001 – FY2005 summarizes the legislative intent contained within the proclamation establishing the Monument as mandating the National Park Service to

- Preserve the geologic spectacle of the Cedar Breaks amphitheater and preserve the scenic vistas as seen from various points along the rim of the amphitheater.
- Preserve all other park resources that are of scientific interest, including geologic, floral, faunal, and cultural resources contained within the boundaries of the monument.
- Interpret the value of and promote public appreciation and enjoyment of Cedar Breaks National Monument.

Therefore, the purpose of Cedar Breaks National Monument is

- To preserve the geology, vistas, natural and ecological processes, and other features of scenic, scientific, and education interest of Cedar Breaks National Monument.
- To provide opportunities for research, public enjoyment, inspiration, and appreciation of the resources of Cedar Breaks National Monument through interpretation and other educational endeavors.

Location CEBR is located in southwestern Utah in Iron County, 29 kilometers (18 miles) east of Cedar City, Utah, on the western edge of the Markagunt Plateau. Its location is also on the western edge of the Colorado Plateau physiographic province, with spectacular views westward into the Basin and Range province.

Elevation Elevation varies from 3,250 meters (10,662 feet) in the northeastern section above the amphitheater rim, to 2,469 meters (8,100 feet) on Ashdown Creek on the western boundary.

General Description CEBR contains an outstanding scenic multi-colored geologic amphitheater, 762 meters (2,500 feet deep) and 5 kilometers (3 miles) wide, eroded from the Claron Formation, and located on the western edge of the 3,353 meters (11,000-foot) Markagunt Plateau.

The Claron Formation, the primary geologic unit, was a limy ooze deposited in shallow Eocene lakes near sea level about 55 million years ago. A general uplift and development of fault blocks occurred during the Miocene, dated about 14 million years before present. The Cedar Breaks amphitheater is an escarpment facing westward with rims on the north, east, and south. The cliffs and canyons of Cedar Breaks have been carved into the western edge of the Markagunt Plateau by the headwaters of Ashdown Creek and its tributaries. Iron and manganese minerals in the rock produce a wide range of red, yellow, orange and purple hues across the cliffs. While this is the same geological formation preserved at Bryce Canyon National Park, variations in the rock layers and differences in the action of the geological processes have produced more colorful scenic vistas at Cedar Breaks but with fewer spires, pinnacles and arches
found at Bryce Canyon.

The rim features a mixture of spruce/fir forest and subalpine meadows. Throughout summer meadows abound in a dazzling profusion of wildflowers peaking midsummer with a magnificent display across the meadows and into the forests. At the very edges of the cliffs, ancient Bristlecone pine trees thrive in the harsh exposed environment to which they are so well adapted. The oldest Bristlecone known in the monument is about 1,700 years old.

The tropical Gulf, tropical Pacific, and polar Pacific air masses influence the climate. Their influence, combined with elevation, produces annual precipitation significantly higher than much of the surrounding terrain. In the winter, storms move in from the west, southwest, and northwest; most moisture falls as snow, closing roads from November to mid-May. A dry southwest flow prevails in summer, with occasional thundershowers that move in from the Gulf of Mexico or rotate around high pressure systems.

Climate data is recorded at the Blowhard Mountain radar site, located about one mile south at an elevation of 3,262 meters (10,700 feet). Mean annual precipitation is 29.73", from a low of 16.90" (1989) to a high of 47.24" (1966). Mean annual maximum temperature is 42.3 F, ranging from a January low of 27.4 to a July high of 62.5, while mean annual minimum temperature is 27.2 F, ranging from 12.4 in January to 47.4 in July. Mean monthly minimums are above 32 F only in June, July, August, and September. The result is long, cold winters, and short, cool summers. Annual cumulative snowfalls can exceed 9 meters (30 feet).

Flora Plant communities are those associated with the pinyon-juniper forests of the lower Transition Zone, to ponderosa pine, blue spruce, and Douglas fir overstory with Rocky Mountain maple, greenleaf manzanita, and/or Oregon grape understory of the Canadian Zone, up to the Englemann spruce-subalpine fir overstory with monkshood, Oregon grape, and/or gooseberry understory and subalpine meadows of grasses, sedges, and forbs

of the Hudsonian Zone. A wide variety of plant life exists due to the wide range in elevation and micro-habitats found within each.

Of the 269 plant species identified in 1989 (Roberts and Jean), twelve are introduced from other continents and are exotics to the native flora. The most widespread is the dandelion (*Taraxacum officinale*) and smooth brome grass (*Bromus inermis*).

Fauna As with vegetation, the topographic diversity supports a large variety of animal life. Thirty-seven mammal and 86 bird species have been identified, although a complete, intensive survey has not been done. Elk, mule deer, mountain lion, and black bear are the dominant large animals found throughout the various elevation ranges, although sightings of mountain lions and bears are rare. The higher elevations provide habitat for the pika, marmot, badger, and porcupine. Middle elevations support gray fox and coyote. A large number of rodents and birds are also present, including the Colorado chipmunk, golden-mantled ground squirrel, pocket gopher, golden eagle, Clark's nutcracker, common raven, violet-green swallow, and white-crowned sparrow. Peregrine falcons have been seen nesting just outside the park to the north and some have been observed in the park. There is little information on reptiles or amphibians.

Aquatic Resources The only fish species known is the brook trout (*Silvelinus fontinalis*), an introduced species. Alpine Pond contains a population of these exotic trout that remain from several decades of artificial stocking. Prior to stocking, no naturally occurring fish species were present. There is no other information available on the aquatic life of Cedar Breaks.

Unique Features and Species of Special Concern

Vegetation Communities A large portion of the of the park has been affected by the spruce bark beetle epidemic that has killed thousands of acres Englemann spruce stands on the Markagunt Plateau. It is estimated that 80 to 90% mortality has occurred in the northern half. The park has been working closely with the U.S. Forest Service since the epidemic began in 1993 with monitoring activities and in determining appropriate steps to mitigate the impact of the epidemic within the park. According to the USFS survey, the outbreak hit a new high in 1997, with a general expansion into the remaining live host occurring. Mortality had expanded in all directions from the Sidney Valley area, just northeast of the park, and continues to push into the park. It is predicted that mortality totals will increase until most of the live host trees in the affected areas are killed. This appears to be the stand replacing event that studies have shown occurs every 300 to 500 years in the process of forest succession. Subalpine fir, aspen, limber pine and bristlecone pine are unaffected by this insect, but dramatic changes in the composition and structure of the high elevation forest within the park are occurring.

Species of Special Concern In their 1989 final report entitled “Plant Community and Rare and Exotic Species Distribution and Dynamics at Cedar Breaks National Monument,” Roberts and Jean list seven plant species described as “rare.” The report further states that plant rarity does not necessarily imply endangerment or possible extinction, but may imply a restricted geographic range or distribution due to physical, biological or man-

induced factors. These plant species at Cedar Breaks are associated with the unique geologic Claron limestone formation, which provides habitat. The nature of endemism with its narrowly restricted plant populations led the U.S. Fish and Wildlife Service to consider many of the endemic plants of CEBR for listing as threatened or endangered. These are plants that were formerly listed as "Category 3" or "candidate" species, but are now referred to as "Special Concern" species. They include Navajo Lake milkvetch (*Astragalus limnocharis*), Least spring parsley (*Cymopterus minimus*), Red Canyon catchfly (*Silene petersonii)*, Reveal's paintbrush (*Castilleja parvula* var. *revealii)*, Cedar Breaks goldenbush (*Haplopappus zionis),* cliff jamesia (*Jamesia americana* var. *zionis)*; and cliff daisy (*Erigeron proselyticus)*.

Since that report, another special concern species has been documented in CEBR. The U.S. Fish and Wildlife Service proposed Arizona willow (*Salix arizonica*), for listing as an endangered species with critical habitat in 1992. At that time, it was known to occur only in an area of east central Arizona; no one was aware that the species occurred in Utah. A collection dating to 1913 from what is now the Dixie National Forest prompted fieldwork in 1994 to determine the extent of this species in Utah, prior to the final determination for listing the species as endangered. The 1994 fieldwork resulted in the discovery of populations in Utah that far exceed the number of total plants from Arizona and significantly expanded the known range of Arizona willow. One of the largest known contiguous stands of Arizona willow shares a common boundary between the Dixie National Forest and CEBR. The U.S. Fish and Wildlife Service and the U.S. Forest Service developed a conservation plan for the species that would provide for implementation of short- and long-term protective measures to reduce threats to the species and its habitat (USDA Forest Service et al. 1995). CEBR is a signatory to this agreement.

Resource Management Concerns

Recreation Use Visitor use has been steadily increasing over the last decade. Annual visitation has grown from just over 400,000 in 1992 to over 650,000 in 1999. Because of the inaccessibility of the geologic amphitheater to hikers, virtually all visitor use occurs on the rim along the scenic drive and at rim overlooks. Parking areas and the campground fill to capacity frequently, increasing the occurrence of off-trail hiking, off-road parking/driving, and out-of-bounds camping, with resultant damage to vegetation and soils.

Hazard Tree Management The large number of dead trees from the spruce bark beetle epidemic (see above), and the properties of aging subalpine fir and aspen that make them prone to structural failure, has increased the occurrence of falling trees in and around developed recreation areas, in the vicinity of historic structures, and along the road corridors. Hazard trees are being evaluated in accordance with the park's Hazard Tree Management Plan, and each year numerous trees are removed from high-risk areas. The scale of this problem has grown considerably in the years following the beetle outbreak, with the potential for serious threats to visitor safety and the preservation of important cultural resources.

Adjacent Land Uses/Impacts on Vistas CEBR is surrounded on all sides by the Dixie National Forest, with about one mile of frontage along the eastern boundary that is in

private ownership. The Brian Head Ski Resort is less than three miles to the north. The development of private lands with summer homes, commercial logging on both private and Forest Service lands, and grazing and hunting activities occur right up to park boundary fences. Trespass grazing and illegal hunting within the park are fairly common. The extent to which these adjacent land uses are impacting park plant and animal resources is largely unknown.

In addition, the expansion of the Brian Head Ski Resort, special use permits on the Dixie National Forest that have resulted in the installation of a large FAA radar dome and a NOAA Nexrad radar dome, both on Blowhard Mountain, and the growth of Cedar City to the west have all resulted in visual impacts to vistas that are a significant and valuable park resource. The gradual expansion of housing developments and light industry to the west of Cedar City, and visible from park overlooks, has also contributed to light pollution that will eventually affect the night skies visible from the park.

COLORADO NATIONAL MONUMENT (COLM)
Size 8,310 hectares (20,534 acres)

Park History and Purpose Colorado National Monument was established by William Howard Taft's Presidential Proclamation (Number 1126) on May 24, 1911. In 1916 the NPS was created and assumed administration of Colorado National Monument. The Proclamation stated that the purpose of the Monument was to reserve in the public interest "the extraordinary examples of erosion (which) are of great scientific interest…together with as much public land as may be necessary for the proper protection thereof."

Subsequent proclamations have broadened the original mandate for managing Colorado National Monument. The Hoover Proclamation of 1933 added "certain adjoining lands for the purpose of including …features of historic and scientific interest and for the protection of the rim road and for administration purposes..." The Eisenhower Proclamation of 1959 reaffirmed the above proclamation.

The Colorado National Monument Resource Management Plan (NPS 1999a) describes its purpose as:

- preservation of its resources for scientific and public interest, and
- protection of the Rim Rock Drive for the general use and enjoyment of the public.

Location Colorado National Monument is located in west-central Colorado in Mesa County just west of Grand Junction. The Monument is about 16 kilometers (10 miles) long and 5 to 10 kilometers (3 to 6 miles) wide. It is situated on the northeastern edge of the Colorado Plateau at the transition to the Rocky Mountain province.

Elevation Elevation ranges from 1,408 meters (4,620 feet) at the foot of the cliffs to 2,166 meters (7,107 feet) on the mesa above the canyons.

General Description Colorado National Monument lies on the northeastern edge of the Uncompahgre Plateau where it abruptly terminates and adjoins the Grand Valley. The landscape contains outstanding geologic features, exposed and sculpted by erosion. Geologic history, ranging from the ancient crystalline rocks of the Precambrian age to the soft, mixed shales and sandstones of the Jurassic age Morrison formation, is recorded in the exposed cliffs. The massive Wingate formation, lying midway in the stratigraphic sequence, forms the steep canyon walls and dominates the scenery (Sloan 1995).

A semi-desert upland climate prevails, with an average of less than 280 millimeters (11 inches) annual precipitation. Temperatures vary from summer highs in the high 90's to winter lows sometimes dipping into the sub-zero range. Snowfall averages 96 centimeters (38 inches), with the heaviest accumulations usually in January.

There are no perennial streams in the monument, but there are ephemeral surface flows, seeps and potholes that supply water for wildlife throughout most of the year.

Flora Dominant vegetation communities are the pinyon-juniper woodland, grassland, and upland shrub communities typical of the Colorado Plateau Physiographic Province. The

pinyon-juniper woodland densely covers the higher elevations above the cliffs, and sparsely covers canyon sides. Thick stands of Gambel oak are found within the upper reaches of some drainages. Open areas dominated by big sagebrush (*Artemisia tridentata),* rabbitbrush (*Chrysothamnus* spp.), and greasewood (*Sarcobatus* vermiculatus) are scattered in canyon bottoms. Riparian communities in canyon bottoms include coyote willow/horsetail (*Salix exigua/Hippochaete hyemalis*) and Tamarisk/Russian olive (*Tamarix chinensis/Eleagnus angustifolia).* Other species in riparian zones include Rocky Mountain willow (*Salix monticola),* western river birch (*Betula occidentalis*) (Lyon et al. 1996), and several orchids.

The monument provides excellent examples of plant communities in near pristine condition.
Researchers documented one relict site on an isolated mesa with a community of pinyon pine/mountain mahogany (Pinus edulis/Cercocarpus montanus) in 1990 (Van Pelt et.al. 1991). They also found relict species including Douglas fir (*Pseudotsuga menziesii*) and manzanita (*Arctostaphylos patula)* elsewhere in the monument.

Grazing by an introduced herd of bison, eliminated in 1983, altered vegetation cover and composition in monument area below the cliffs. Exotic invasive species were introduced in canyon riparian habitats, along roadsides and in other disturbed sites. A complete inventory of exotic species has yet to be accomplished.

The vascular flora record includes more than 66 families, 250 genera and 450 species, based on specimens in the COLM herbarium and on the checklist developed in 1985 (Weber et al.). An identification guide for cacti describes nine species (Campbell 1996). The Colorado Natural Heritage Program lists 14 sensitive plant species for the Monument. Only 55 lichen species have been identified.

Fauna The checklist of mammals includes 64 species, of which 41 have actually been recorded (Armstrong and Rector 1988). Desert bighorn sheep were reintroduced in 1979. Twelve bat species are known to be present; there is suitable habitat for five additional species (Perrotti 1995). A herd of bison was introduced and maintained from 1925 to 1983.

The checklist for birds includes 127 species (Kaeding 1990). Monitoring projects are ongoing for peregrine falcons and gray vireos.

The checklist of amphibians and reptiles includes 25 species: one salamander, two toads and two frogs, one turtle, nine lizards, and nine snakes. Rare species of note are the midget-faded rattlesnake (*Crotalus viridus concolor*) and Utah blackhead snake (*Tantilla planiceps*); the clouded tiger salamander (*Ambystoma tigrinum),* Great Basin spadefoot (*Saphiopus intermontanus*), and canyon treefrog (*Hyla arenicolor*).

Arthropods have been recorded in a 23 page checklist produced in 1994 (Kondratieff et al.) A list of butterflies and moths includes more than 200 species (Weissmann et al. 1997).

Aquatic Features Springs, seeps and tinajas provide habitat for amphibians and riparian plants. There are no fish within the Monument.

Unique Features and Species of Special Concern

Vegetation Communities Riparian communities in canyon bottoms include coyote willow/horsetail (Salix exigua/Hippochaete hyemalis), which is also habitat for the canyon bog orchid (Platanthera sparsiflora var. ensifolia). Two other plant associations, Utah juniper/Salina wildrye (Juniperus osteosperma/Elymus salinus) and pinyon pine/mountain mahogany/Salina wildrye (Pinus edulis/Cercocarpus montanus/Elymus salinus) are identified in the 1984 "Plant Associations of Special Concern in Colorado" (NPS 1999a).

Plants Of the 14 sensitive plant species listed for the Monument by the Colorado Natural Heritage Program, at least two need status surveys and monitoring. The Canyonlands lomatium (*Lomatium latilobum*) is ranked G1 S1, and described as "one of the rarest plants in Colorado" (Lyon et al. 1996). It grows on climbable shelves of the Wingate sandstone cliffs in canyons that are popular for hikers. Canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) (G4G5T3S2) depends on a reliable supply of moisture year-round, which is found only in a few canyon seeps. In addition, Uinta Basin hookless cactus (*Sclerocactus glaucus*), a listed Threatened species, has been reported (unverified) at one location in the Monument close to a suburban development.

Animals COLM provides a critical and protected haven for Coloradoan bats. Of the 12 bat species that are known to be present, the Townsend's big-eared bat (*Plecotus townsendii pallencens*) is listed as a former species of concern; it is the major impetus and focus of the Colorado Division of Wildlife's Bat/Abandoned Mine conservation project. The fringed myotis (*Myotis thysanodes*) and the big free-tailed bat (*Nictinomops macrotus*) are also considered rare in Colorado. There is potential habitat for the endangered spotted bat (*Euderma maculatum*).

There have been inventories, mapping and ongoing monitoring of American peregrine falcon (*Falco peregrinus anatum),* and the gray vireo (*Vireo vicinior*) and plumbeous vireos (Giroir 1999). The National Audubon Society recently designated COLM as an Important Bird Area.

The desert bighorn sheep population is estimated at 75 individuals. The Colorado Division of Wildlife continues to monitor the herd (Sloan 1995).

Rare reptile and amphibian species of note are the midget-faded rattlesnake (*Crotalus viridus concolor*) and Utah blackhead snake (*Tantilla planiceps*); the clouded tiger salamander (*Ambystoma tigrinum*), Great Basin spadefoot (*Saphiopus intermontanus*), and canyon treefrog (*Hyla arenicolor*). University of Windsor, Ontario, researchers conducted Iguanid lizard surveys and behavioral studies from 1988 to 1994.

Outside researchers discovered five new moth species in 1998. Independent surveys for lepidoptera should be supplemented with inventories, monitoring and documentation by NPS to enable management planning for this resource.

Resource Management Concerns
Planning Comprehensive biological inventories for use in planning and management of natural resources have not been completed for any taxa.

Recreational Use The number of hikers entering from public trailheads near Grand Junction and from residential developments at canyon mouths is increasing rapidly. A baseline documentation and condition assessment of the trails system is underway in preparation for development of a trails management plan. Baseline inventories of riparian habitats and sensitive amphibian and plant species in these canyons need to be completed and coordinated with the trails planning.

Hiking in canyons and off-road vehicle intrusions from BLM land in the backcountry threaten to accelerate erosion of geologic resources. Monitoring of vegetation cover and mapping of social trails could provide measurements of the impacts.

Land Use Impacts Growth in the Grand Valley has brought housing and commercial buildings up to the boundary. Increased public use of BLM lands along the western boundary also impacts resources. Inventories and monitoring resources are needed to provide information for a sustainable Resource Management Plan.

Sensitive Plant species The Canyonlands lomatium (*Lomatium latilobum*) grows on climbable shelves of the Wingate sandstone cliffs in popular hiking areas where trails are unmarked. The canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) grows in wet areas of canyon bottoms that attract hikers. Plant populations need to inventoried, mapped, and protected by marking trails to route hikers around sensitive habitat.

Vegetation Management Utah juniper and pinyon pine tree mortality rates have increased over the past several years. They have a root fungus, probably augmented by drought stress. A determination should be made as to mortality causes, whether natural or anthropogenic, and the effect on other NPS areas as well. Mitigation measures and monitoring of causal factors should be considered (NPS 1999a).

Fire potential is a concern because of adjacent residential areas. Increasing numbers of dead trees and increasing cheatgrass cover are two factors that contribute to fuel load. Collection of natural fire regime data and monitoring of vegetation and ground cover is needed to provide information for fire management.

Permanent vegetation monitoring plots were established in several locations in 1982 and read in 1985 to measure effects of air pollution from a refinery in Fruita. The refinery is not in operation now. Recent samples of lichens and cryptobiotic crusts show evidence of damage attributable to air pollutants (NPS 1999a). Lichens on the cliffs that face the adjacent city of Grand Junction could provide a monitoring tool for measuring air pollution affects on monument vegetation.

Invasive Exotic Plant Species Tamarisk (*Tamarix ramosissima*) has received the most attention at COLM, starting in about 1995. The Lake Mead tamarisk terminators treated all except about 15 kilometers (9 miles) of canyon habitat in 1997. Monument staff and

volunteers have continued treatments and follow-ups each year. Pre-treatment maps are in the monument GIS. Additional follow-up treatments and documentation are needed.

Russian olive (*Eleagnus angustifolia*) was removed and needs follow-up documentation. Other species of greatest concern are Russian knapweed (*Centaurea repens*) and cheatgrass (*Bromus tectorum*). The knapweed populations, mapped and sprayed for several years, continue to need follow-up spraying and documentation. Cheatgrass exists throughout the monument in areas impacted by past bison grazing as well as other disturbances; on some roadsides it is found to the exclusion of other species.

Yellow sweet clover (*Melilotus officinalis*) has been sprayed along some roadsides. This species and the Russian thistle (*Salsola australis*) have not had a treatment plan implemented.

Animals There are no data on mountain lion population size and movement. In anticipation of potential conflicts between increasing visitation, basic data needs to be collected and maintained .

Amphibian reproduction is threatened by recreational use of ephemeral pools in the lower canyons where hikers play in water. Amphibian surveys and monitoring data are needed for trail planning and recreation management.

The desert bighorn sheep herd is being monitored. There is continued mortality among adults and lambs. Recommendations are for one or two additional translocations (Singer 1998).

The Colorado Division of Wildlife and COLM have collected many years of site data for peregrine falcons (Falco peregrinus). These data need to be consolidated.

Prairie dogs towns along the boundary with residential subdivisions should be monitored periodically.

CURECANTI NATIONAL RECREATION AREA (CURE)
Size 17,433 hectares (43,078 acres)

Park History and Purpose Curecanti National Recreation Area is administered by the NPS through a February 11, 1965 Memorandum of Agreement between the NPS and the Bureau of Reclamation and is part of the National Park System. The recreation area is composed of a chain of three reservoirs impounded on the Gunnison River. The reservoirs comprise the Wayne N. Aspinall Unit (formerly the Curecanti Unit) of the Colorado River Storage Project operated by the U.S. Bureau of Reclamation (BOR). Curecanti draws its purpose from the 1965 Memorandum of Agreement as well as from the Colorado River Storage Project Act, Chapter 203 enacted April 11, 1956, as

> Sec. (1) "... the Secretary of the Interior is hereby authorized to construct, operate, and maintain the following initial units of the Colorado River Storage Project, consisting of dams, reservoirs, power plants, transmission facilities and appurtenant works;"
>
> Sec. (8) "… the Secretary is authorized and directed to investigate, plan, operate and maintain (1) public recreational facilities on lands withdrawn or acquired for the development of said project or of said participating projects, to conserve the scenery, the natural, historic, and archeological objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects by such means as are consistent with the primary purposes of said projects; and (2) facilities to mitigate losses of, and improve conditions for, the propagation of fish and wildlife."

Curecanti National Recreation Area's General Management Plan (NPS 1997a) provides guidelines for future management. It identifies management actions that satisfy public needs while protecting natural and cultural resources. The General Management Plan identifies the purpose for Curecanti National Recreation Area as follows:

- "To conserve the scenery, natural, historic, and archeological resources, and wildlife of Curecanti National Recreation Area."
- "To provide for public use and enjoyment in such a way as to ensure visitor safety and resource preservation or conservation by establishing and maintaining facilities and providing protective and interpretive services."

The General Management Plan identifies one of the park mandates for Curecanti National Recreation Area as:

- "To mitigate the loss of fish and wildlife resources as a result of the Colorado River Storage Project."

Building on the objectives put forth in the General Management Plan, the specific objectives identified in the Curecanti National Recreation Area Resource Management Plan (NPS 1995a) for the stewardship of natural resources are:

- Maintain, restore, or simulate natural terrestrial, aquatic, and atmospheric ecosystem conditions and processes to the degree that is physically possible, so they may operate unimpaired from human influences.
- Maintain or restore indigenous flora, fauna, and natural communities to achieve species diversity and community structure equivalent to pre-Columbian times or post-Columbian conditions that would have been created by natural events and processes.
- Protect rare species by measures aimed at preventing extirpation but which minimize adverse influences on other indigenous species.
- Encourage and participate in efforts to acquire and analyze information through research to facilitate development of the best possible management strategies for resource protection.
- Conduct long-term ecological monitoring and work cooperatively with other agencies to minimize, mitigate or prevent resource damaging human influences resulting from activities inside and outside of park boundaries.
- Permit only those types and levels of development that do not significantly impair park resources, and direct development to environments least vulnerable to resource degradation.

Location Curecanti is located in Colorado's Third Congressional District within Gunnison and Montrose Counties. The recreation area is located approximately 315 kilometers (196 miles) southwest of Denver, Colorado and 24 kilometers (15 miles) west of Gunnison, Colorado.

Elevation Elevations from 1,981 meters (6,500 feet) at East Portal to 2,896 meters (9,500 feet) near Sheep Knob), in combination with slope, geology, and aspect, have created diverse habitats that support a wide variety of vertebrate and plant species.

General Description The West Elk Mountains to the north, the Sawatch Range to the east, and the San Juan Mountains to the south frame the Gunnison River Valley. The modern Gunnison River was established in its current course about 10 to 15 million years ago, just after the last eruptions in the San Juans and West Elks. This coincides with the beginning of rapid uplift of the Great Basin and Colorado Plateau provinces that lie between the Rockies and the Sierra Nevada Range in California. The uplift allowed the early Gunnison River to easily cut its way down through the thick layers of Tertiary volcanics and Mesozoic sedimentary rocks. Two million years ago, the river began to expose the much harder Precambrian basement rocks of the Gunnison Uplift. At the rate of about one inch per every hundred years, the Gunnison slowly worked its way through resistant rock, forming the narrow, steep-sided Black Canyon of the Gunnison. The volcanic deposits have since eroded on the mesa faces surrounding Blue Mesa Reservoir, forming spires and pinnacles as seen on Dillon Mesa. The towering Canyon walls are an imposing feature of Morrow Point and Crystal Reservoirs. Morrow Point's Curecanti Needle, sculpted from the canyon wall, stands as an excellent example of North American Precambrian bedrock.

Blue Mesa Reservoir, one of three reservoirs and the largest body of water entirely within Colorado, is situated in the Gunnison River Valley characterized by bordering steep

bluffs and high mesas. Blue Mesa supports the largest Kokanee Salmon fishery in the United States.

Temperatures range from a low of -30°F (-34°C) in the winter to highs of approximately 85°F (29°C) in the summer. Average annual precipitation is approximately 280 millimeters (11 inches). Most precipitation occurs in spring and summer rains. The wind is predominantly from the southwest with episodes of high velocity. Canyon bottoms are typically 10° to 15°F (5° to 8°C) warmer than rimtops during summer months.

Flora The shoreline slopes surrounding Blue Mesa Reservoir are covered with grasses, big sagebrush, rabbitbrush, and Gambel oak gradually reaching 2,743 meters (9,000 feet) mesas. The mesa tops are characteristically covered with high desert vegetation; however, there are intermittent pockets of Douglas fir, quaking aspen, and spruce. Separating the mesa tops are north-south running canyons that contain lush riparian flora. Morrow Point and Crystal Reservoirs, both narrow fiord-like lakes, are situated in the Black Canyon of the Gunnison River. Shrubs and conifers cover the north facing slopes and canyon rims along both of these lower, narrow reservoirs. Located within the park boundary are 18 kilometers (11 miles) of the Gunnison River and 85 kilometers (53 miles) of tributary streams.

Fauna There are at least 51 species of mammals and over 220 species of birds that make up the base of Curecanti's wildlife resource. Some are permanent residents, others use the park as a wintering ground and still others are migratory in nature.

Aquatic Features The Upper Gunnison River watershed, upstream of the western boundary of CURE, drains approximately 3,965 square miles. Located within the boundary are approximately 18 kilometers (11 miles) of the Gunnison River and 85 kilometers (53 miles) of tributary streams. The eastern-most portion of CURE is comprised of a riverine system, essentially unaltered since reservoir construction. This historic system encompasses an alluvial floodplain and is prone to natural flood events and channel avulsions. This diverse riparian area harbors a mature cottonwood (*Populus angustifolia*) overstory with an herbaceous understory. Numerous ephemeral pools and wetland areas adjoin the river and harbor a diverse assemblage of vertebrate and invertebrate fauna. The Gunnison River, providing 50% of the inflow to Blue Mesa Reservoir, is of good quality and supports both native and stocked trout fisheries. Many high mountain streams, which form tributaries that enter Curecanti's reservoirs, originate from areas where the stream water quality is excellent. Many of these streams are relict and support high quality, functioning aquatic systems. The effects of past mining activity, naturally occurring mineral contamination, grazing, logging, road construction, and creational activities, have degraded several streams in the upper portion of the basin. As these waters progress downstream toward Blue Mesa Reservoir, additional factors, including point and non-point sources such as municipal and industrial discharges, domestic sewage discharges, irrigation diversions, overland agricultural runoff, and gravel mining and stream channelization, have potential to altering their quality. Some tributaries inside CURE that flow into Blue Mesa, Morrow Point, and Crystal Reservoirs were identified as potential sites for reintroduction of Colorado River Cutthroat Trout. The Nature Conservancy has identified several other tributaries as potential relict sites for

inclusion as research natural areas. Blue Creek was noted as having significantly secluded and riparian attributes and requires further research.

Unique Features and Species of Special Concern
CURE lies in the heart of one of the most scenic areas of the Central Rockies, well known for its wide vistas and views of distant peaks. The natural environment surrounding CURE provided rich hunting and food gathering for the prehistoric peoples of the Gunnison area. The abundance of wildlife, natural beauty, and diversity of recreational opportunities draws people today.

Plants and Vegetation Communities CURE's diverse vegetative resources include native and exotic species, irrigated meadowlands and site-specific landscaped zones. This vegetation provides an opportunity for visitors to understand, experience, and enjoy the scenic and natural vegetative resources of the western slope of the Rocky Mountains. Four rare plants are either known or suspected to occupy lands within Curecanti including Black Canyon gila *(Gila pentstemonoides),* hanging garden sullivantia *(Sullivantia hapemanii* var. *purpusii),* skiff milkvetch *(Astragalus microcymbus),* and Gunnison milkvetch *(Astragalus anisus).* Unique geological conditions and semi-arid environments combine to create a number of habitats of particular interest including seeps, springs, riparian areas, and hanging gardens.

Animals The park's geographic location, along with the resources it offers, makes Curecanti an attractive site for a number of sensitive and rare wildlife species. Bald eagles, osprey and an occasional whooping crane employ the riparian features during periods of migration. A great blue heron rookery occurs in the riparian habitat found in the eastern portions, and it is suspected that the southwestern willow flycatcher uses riparian features. Peregrine falcons nest on the cliffs. Western burrowing owls have been documented using prairie dog burrows within the abandoned hay meadows that make up the east-central portion. The Gunnison sage grouse, a recently recognized species, uses the sagebrush habitats within and surrounding CURE to meet their year-round habitat needs.

Curecanti supports populations of large mammals including elk, mule deer, bighorn sheep, mountain lion, black bear, and coyote. Prior to impoundment, the area flooded by Blue Mesa Reservoir was one of the main wintering grounds for elk, mule deer and bighorn sheep. Since impoundment, the entire bottomland and associated forage has been lost, and the seasonal migration of these animals has been restricted. Elk and deer presently use t the north shore of Blue Mesa Reservoir during the winter where as many as 1,200 elk in several herds have been observed.

The Gunnison prairie dog is an abundant species that uses open grasslands around Blue Mesa Reservoir. Regionally, there is concern about the status of this species because of continued habitat loss. The Black Canyon of the Gunnison provides excellent habitat for bats, but little is known about the status of bats CURE.

Although water impoundments in the Curecanti project have altered fish propagation, a fish management and stocking program on Blue Mesa has increased the valuable fishing resource and contributed to fishing activities throughout the region. Currently kokanee

salmon and four varieties of trout including brook trout, rainbow trout, brown trout, and Mackinaw trout provide fishermen of the Gunnison River, the three reservoirs, and the many side streams with high quality fishing.

Resource Management Concerns

Livestock Grazing Livestock production and irrigated farming have been a way of life since the mid-nineteenth century. The principal use of land surrounding CURE continues to be livestock grazing. Recurring problems are developing between grazing and wildlife habitat and recreational use such as camping, picnicking, shoreline fishing, and hiking. These problems are associated with stock driveways, timing of seasonal grazing use, stocking levels and inadequate fencing. Lack of fencing has resulted in livestock trampling of riparian vegetation, soil compaction, and streambank erosion. Livestock grazing may be affecting Gunnison sage grouse, elk, mule deer and bighorn sheep habitat.

Exotic Plants and Animals Exotic plant species are invading both disturbed and undisturbed areas, displacing native species. Exotic vascular plants of particular concern include cheatgrass *(Bromus tectorum)*, Canada thistle *(Cirsium arvense)*, bull thistle *(Cirsium vulgare)*, musk thistle *(Carduus nutans)*, Russian knapweed *(Centaurea repens)*, spotted knapweed *(Centaurea maculosa)*, hoary cress *(Cardaria draba)*, perennial pepperweed *(Lepidium latifolium)*, yellow toadflax *(Linaria vulgaris)*, common mullein *(Verbascum thapsus)*, black henbane *(Hyoscyamus niger)*, and tamarisk *(Tamarix ramosissima)*.

While the introduction of exotic fish species into the stream and reservoir system created within the recreation area has increased the valuable fishing resource from a sport fishery standpoint, it has also impacted native species. The native fish species of particular concern is the Colorado River cutthroat trout *(Oncorhynchus clarki pleuriticus)*, which still occupies some headwater streams that feed the recreation area.

Land Use Conversion Increased near-park development is having visual and biological impacts on resources. Habitat loss as a result of Blue Mesa Reservoir and other adjacent development has affected Gunnison sage grouse, Gunnison prairie dogs, elk, deer, and bighorn sheep as well as numerous other species in the

Visitor Use Increasing visitor use through the 1980s and into the 1990s contributed to direct impacts to soil and vegetative resources which have indirect effects on sensitive habitats and wildlife species.

Altered Hydrologic Regime Construction of dams and water diversions and the destruction of riparian habitat have altered stream flow patterns, temperature regime, fish spawning habitat, fish species and fish-food organisms on the Gunnison River.

Past Fire Exclusion The natural systems within and surrounding CURE have evolved with fire. The presence or absence of natural fire within a given habitat is one of the ecological factors contributing to the perpetuation of plants and animals in that habitat. Fire suppression has contributed to an alteration of plant communities.

Lack of Basic Data A great deal of baseline information about the presence or absence, abundance and distribution of natural resources is needed to assist managers in making informed decisions which may have effects on natural resources. Management has an insufficient understanding of park ecosystems and threats to them.

DINOSAUR NATIONAL MONUMENT (DINO)
Size 85,097 hectares (210,278 acres)

Park History and Purpose Dinosaur National Monument was established by Presidential Proclamation 1313 on October 4, 1915 (39 Stat. 1752), as an 80-acre monument to preserve the outstanding fossil resources at the dinosaur quarry north of Jensen, Utah. In 1938, Presidential Proclamation 2290 enlarged the monument to 82,510 hectares (203,885 acres) (53 Stat. 2454). This proclamation cited the Act of August 25, 1916, that established the NPS (16 U.S.C. 1a-7), thereby specifically identifying Dinosaur National Monument as an area to be administered for purposes of preservation of natural resources and public use. A major focus of expansion of land base was protection of river corridors and adjacent view sheds for the major canyons of the Green and Yampa Rivers.

On September 8, 1960, Congress passed Public Law 86-729, 74 Stat. 857. This key piece of legislation enlarged the monument to 85,447 hectares (211,141.69 acres). P.L. 86-729 also established procedures directed toward the eventual elimination of grazing from the monument.

Due to its complex natural and cultural resources, a number of other Federal laws and Executive Orders influence both short-term and long-term resource management decisions in Dinosaur National Monument. Among them are NPS Organic Act (including the Redwood Amendment), National Environmental Policy Act, Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act, Clean Water Act, Executive Order 11988—Floodplain Management, Executive Order 11990—Protection of Wetlands, and Executive Order 13112—Invasive Species.

The primary objectives presented in the park's General Management Plan (NPS 1986) are:

- to protect and preserve the natural and cultural environments;
- to permit biological, geological, and other natural processes to continue with a minimum of human disturbance; and
- to provide opportunities for enjoyable visitor experiences as well as an understanding of the significance of monument resources.

The plan details numerous issues and concerns related to biological, physical and cultural resources.

The Resource Management Plan specifically identifies several vertebrate and vascular plant species and groups as being of special management concern. These include the endangered Colorado River fishes, peregrine falcon, several other "rare" or sensitive vertebrates, the threatened Ute ladies'-tresses orchid (*Spiranthes diluvialis*) and some 40 other rare plants. Of particular note is the high level of endemism among native fishes and vascular plants.

Location Northwestern Colorado and northeastern Utah on the easternmost extension of the Uinta Mountain anticline (Hansen 1986) at the northern edge of the Colorado Plateau. The monument is shaped somewhat like an inverted T; at its widest and longest dimensions it is 35 kilometers (22 miles) north to south and 71 kilometers (44 miles) east to west. Portions are approximately 32 highway kilometers (20 miles) east of Vernal, Utah; 80 kilometers (50

miles) west of Craig, Colorado; and about 193 kilometers (120 miles) north of Grand Junction, Colorado.

Elevation Elevations range from under 1,448 meters (4,750 feet) near the Quarry to over 2,743 meters (9,000 feet) at Zenobia Peak. Annual precipitation ranges from under 280 millimeters (11 inches) at low elevations to near 508 millimeters (20 inches) at highest elevations.

General Description DINOSAUR includes canyons of the lower Yampa River and of the upper Green River below Browns Park. Using the confluence of the Green and Yampa Rivers in Echo Park as a central point, the park extends upstream on the Yampa some 46 river miles, upstream on the Green about 20 river miles, and downstream on the Green another 25 river miles. The land base extends as far as five miles lateral distance from the river courses. The rivers flow through deep canyons with high velocity/high gradient stream reaches interspersed with more open parks with lower stream gradients.

The park also includes dinosaur fossils of international renown, primarily in the vicinity of the Dinosaur Quarry and its Jurassic fossils. In addition to the Quarry, some 450 other dinosaur fossil sites are exposed on the surface. Fossil materials range from Jurassic to Quaternary and include plant, reptilian and mammal remains. The park also displays the widest range of geologic stratigraphic history on the Colorado Plateau. These features make DINO a preferred site for paleontological and geological research.

Biotic diversity is high due to Dinosaur's location at the convergence of five physiographic provinces—the Colorado Plateau, Wyoming Basin, Great Basin and central and southern Rocky Mountains. Plant communities include montane coniferous forest, pinyon-juniper woodland, mixed mountain shrub, sagebrush-grassland, cold desert shrubland, barrens, and low elevation riparian woodland. Altitudinal juxtapositions are not uncommon. Physiographic location, topography, folding/faulting of geologic substrates, and presence of large desert rivers combine to produce an unusually diverse biota.

Significant endemism is evident in native fish populations (only 8 species) and in vascular flora (15 Uinta Basin endemics among the over 40 rare species). The monument includes the upper/middle Green River and the lower Yampa River. The Yampa River is the only large tributary in the Colorado River system that remains unregulated by a major mainstream impoundment and, as such, is singularly important in sustaining endangered fish in the Upper Colorado River Basin.

About 40 non-native fish and nearly 70 non-native plant species now occupy monument lands and waters. Some of these (e.g., channel catfish, northern pike, tamarisk, perennial pepperweed, Russian knapweed, spotted knapweed, leafy spurge) are of particular concern because of their adverse impacts on native flora and fauna.

Flora Great diversity of geologic substrates combines with extreme topographic variation within DINO to produce plant communities that are nearly all ecotonal (transitional) to some degree. A diverse landscape supports plant communities reminiscent of several ecoregional provinces described by Bailey (1995), including Intermountain semi-desert and desert, Utah mountains semi-desert-coniferous forest, Southern Rocky Mountain steppe-open woodland-

coniferous forest and Colorado Plateau semi-desert. Most of DINO vegetation falls within (Rowlands 1994) montane or submontane/cold temperate lowland zones (Colorado Plateau province). An excellent description of Uinta Basin plant communities is found in Graham (1937). Classification of plant communities is problematic because of variation within the physical environment.

More than 600 plant species have been documented. Approximately 200 more are expected (Naumann, personal communication). Dinosaur's cold desert flora is particularly rich in localized endemic species. Hanging garden communities along the Yampa and Green Rivers and their tributaries exhibit a close relationship with those found lower in the Colorado River drainage (Welsh 1989). Invasive non-native plants threaten native plant communities in a variety of habitats, especially within the river corridors. Prescribed fire has been used extensively in an effort to restore native grassland communities degraded by livestock grazing and fire suppression.

Fauna Over 200 bird species, 16 reptile species, 6 amphibian species, about 50 fish species, and nearly 70 mammalian species. Large ungulates include elk, mule deer, bighorn sheep and moose; bison have been extirpated. Large mammalian predators include mountain lion, bobcat, coyote, fox and black bear; grizzly bear and wolf have been extirpated. Nearly the entire Colorado bat fauna is represented in Dinosaur (approximately 15 species). Raptors include peregrine and other falcons, Mexican spotted owl, bald and golden eagles, osprey, accipiters, harriers, hawks and other owls. Non-native species are a notable problem only within the fish component where multiple non-native species prey on or compete with various life stages of endangered fishes.

Unique Features and Species of Special Concern

Vegetation Communities Plant communities of special concern include hanging gardens, riparian woodlands and related floodplain habitats, mountain mahogany tall shrublands, limestone barrens, and wetlands associated with tributary streams or upland springs and seeps. Fremont cottonwood demonstrates a unique recruitment strategy along the Green and Yampa Rivers, with DINO (David Cooper, personal communication). Dinosaur represents a unique and important ecological research opportunity in that both the Yampa (unregulated) and the Green (regulated) Rivers drain similarly sized watersheds and have their confluence in the park. Comparisons between the two river systems have produced a great deal of useful ecological information. Several rare plants are associated with mesic habitats, including Ute ladies'-tresses orchid, alcove bog orchid (*Habenaria zothecina*), alcove death camas (*Zigadenus vaginatus*), and narrow-leaf evening primrose (*Oenothera* spp.).

Plants DINO provides habitat for approximately 40 rare plant species. Only one is listed as threatened—Ute ladies'-tresses orchid (*Spiranthes diluvialis*).
Four species are ranked as G1; the Utah and Colorado Natural Heritage Programs rank seven species as G2. Approximately 15 species are endemic to the Uinta Basin.

The Green River District (Utah portion) of DINO is an extremely important center of plant endemism in the context of the Uinta Basin (Naumann 1990). Erosion of Split Mountain Anticline exposed numerous geologic formations in a relatively small area. The result is pronounced partitioning of plant habitats, and a concomitant concentration of endemic plant species. Type localities for at least nine endemic plant species occur within

or very near the Green River District. Though less frequent in the Yampa River District, rare plants occur throughout DINOs Colorado portion.

Animals Listed species include the Colorado pikeminnow, humpback chub, razorback sucker, bonytail, Mexican spotted owl, and bald eagle. Species proposed for protection by the Endangered Species Act include spotted bat, roundtail chub, flannelmouth sucker, sage grouse, northern goshawk, and ferruginous hawk. Black-footed ferrets have been reintroduced in the local region; it's not beyond possibility that some individuals could eventually occupy the park. Peregrine falcons, though recently delisted, remain of special concern and the focus of long-term monitoring. Also of management concern due to rarity, sensitivity and/or potential management problems are bighorn sheep, elk and bats.

Resource Management Concerns

Livestock Grazing There remain 11 grazing allotments on approximately 32,375 hectares (80,000 acres) with a total maximum grazing preference of about 2,300 AUMs. Most grazing remaining is appurtenant to inholdings and will therefore not be terminated until inholdings are purchased. Grazing pressure varies by allotment with some livestock use having minimal impacts and some allotments exhibiting significant adverse impacts. Such adverse impacts include shifts in plant community composition toward non-native species, introduction and spread of invasive non-native plants, competition for resources (forage, water, cover) with native ungulates, displacement of native ungulates, potential for disease transmission (particularly with bighorn sheep), destruction of rare plants, damage to riparian resources, damage to upland water sources, damage to cultural resources, and conflicts with recreational uses.

Recreation Use Dinosaur receives about 500,000 visitors annually; the vast majority visits only the Quarry. However, nearly half of total visitor hours are associated with river use. Although the River Management Plan limits whitewater river use (number of launches, group size), impacts of human use in the river canyons appear to be increasing. Among other things, social trails in and near campsites are proliferating; monitoring indicates an increase in bare ground area and in occurrence of human fecal matter. Recreational use impacts are increasing in side canyons and other areas adjacent to the river because of increasing use from travel originating both within and outside the river corridor. Mountain bike use, though nominally confined to existing roads, is increasing along with subsequent adverse impacts (e.g., to microbiotic soils).

Land Use Impacts Only very limited agricultural cultivation occurs on private lands within the monument. Activities on adjacent Federal and private lands have potential to adversely impact resources and resource values. Various land uses, existing and proposed water depletions, and operation of Flaming Gorge Dam significantly and adversely impact resources. There has been an apparent significant rise in pH on the Yampa River—to the point of potential fish kills. Ongoing research is designed to determine if the pH rise is real or an artifact of sampling methodologies. If the increase is real, then research will attempt to identify sources of change. Pursuant to a jeopardy Biological Opinion and flow recommendations for endangered fish, the process is underway to modify operations of

Flaming Gorge Dam to benefit listed species (the 4 endangered fish species and the threatened Ute ladies'-tresses orchid).

Endemic and Special Concern Plant Species The Green River District contains a number of important developed facilities (e.g., campgrounds, boat ramp, picnic area, fossil quarry and visitor center, housing area, maintenance yard, fire cache, hiking trails, etc.). The frequency and density of sensitive plants in the Green River District require frequent clearances for surface-disturbing maintenance and construction activities. Inadequate map and inventory information makes clearance time-consuming, resulting in occasional work delays and/or substandard clearance work.

To date no evidence of plant poaching or intentional damage to sensitive plant species has been documented. Reports of this activity at nearby CARE indicate the possibility exists for exploitation by collectors. Another potential threat arises from road improvements that may lead to increased backcountry use. Known threats to rare plants include unauthorized off-road vehicle use, recreational social trailing, increased use by horses associated with commercial trail rides, changes in livestock grazing use patterns, and invasive species encroachment.

Invasive Exotic Plant Species Sixty-six non-native plant species have been identified in DINO. Fourteen are invasive; these include common burdock, cheatgrass, hoary cress, musk, bull and Canada thistle, spotted and Russian knapweed, Russian olive, leafy spurge, perennial pepperweed, Dalmatian toadflax, yellow sweet clover and tamarisk. Flaming Gorge dam operations, livestock grazing, and external vectors have contributed to invasive plant establishment and spread. NPS (internal) fire management operations, new construction, roadside vegetation management and facility maintenance operations have also contributed. Appropriate weed management and native plant restoration have lagged significantly behind identified needs.

FOSSIL BUTTE NATIONAL MONUMENT (FOBU)
Size 3,318 hectares (8,198 acres)

Park History and Purpose According to the enabling legislation, approved October 23, 1972, Fossil Butte National Monument was created "… to preserve for the benefit and enjoyment of present and future generations outstanding paleontological sites and related geological phenomena, and to provide for the display and interpretation of scientific specimens…"

The enabling legislation also stipulated, in Section 4 (a), that "[f]or a period of ten years, and for not more than ten years thereafter if extended by the Secretary, the continuation of existing uses of Federal lands and water within the monument for grazing and stock watering may be permitted if the Secretary finds that such uses will not conflict with public use, interpretation, or administration of the monument, Provided, That the use of lands within the monument for stock driveways shall continue in perpetuity at such places where this use will not conflict with administration of the monument." The enabling legislation further provided in Section 4 (b), "[u]pon termination of the uses set forth in subsection (a) of this section, the Secretary of the Interior is authorized to provide for the disposition and use of water surplus to the needs of the monument, to a point or points outside the boundaries of the monument."

Grazing was discontinued after the1989 growing season. One remote spring was developed to provide water beyond the boundary for livestock and wildlife.

Today, FOBU continues to protect and preserve portions of the Green River and Wasatch formations which contain a unique fossilized assemblage of organisms that once lived in or around Fossil Lake, an ancient lake of Eocene age. Many other clues to the environment of Fossil Lake and its environs are also preserved in the stratigraphic units of the Wasatch and Green River formations.

Location In southwest Wyoming near U. S. Highway 30, approximately 21 kilometers (13 miles) west of the town of Kemmerer, and 161 kilometers (100 miles) south of Jackson.

Elevation The lowest topographic point is approximately 2,018 meters (6,620 feet) above mean sea level where Chicken Creek crosses the boundary near the main entrance. The summit of the Bull Pen, near the northern boundary, is the highest point. The Bull Pen summit is 2,464 meters (8,084 feet) above sea level.

General Description The boundary encompasses land dominated by sagebrush steppe vegetation. The area is considered to be high, cold desert. Precipitation averages between 229 and 305 millimeters (9 and 12 inches) per year; most of it falling as snow. The mean frost-free period is 59 days. Winters can be extremely cold with the temperatures occasionally falling to -30°F or less. Summer nights are cool with the temperature frequently dropping below 50°F. During the day summer temperatures rarely exceed 90°F.

The uppermost, nearly white strata of the Green River formation is exposed along the steep slopes of Cundick Ridge and along the slopes of Fossil Butte. The Wasatch formation underlies, overlies, and intermingles with the Green River formation, but, to the untrained eye, outcroppings of its colorful dull red, pink, lavender, purple, yellow, and gray strata appear to be scattered at random through the park.

Small, deep, steep-sided valleys, some named by park staff, dissect the highlands. Millet Canyon, on the west side, lies between Ruby Point and the western extent of Cundick Ridge. Murder Hill, Middle, and Moosebones Canyons are on the east side. Ridges projecting eastward from the highlands in the northern half separate these valleys.

Fossil Butte, and Cundick Ridge rise to the east above the Chicken Creek, an interrupted, intermittent stream with ephemeral tributaries, which drains approximately 2/3 of the land. Only the uppermost few hundred yards of Chicken Creek is perennial. Generally, the stream flows throughout its entire length only for a few months during late spring and early summer length when it conveys snowmelt and spring storm runoff. Slopes on the eastern side of the watershed are steep (7.5% to 20%). Below 2,073 meters (6800 feet) elevation the gradient of Chicken Creek is 1%-2%. The lower reaches of Chicken Creek are severely eroded. Historically, railroad construction reduced the stream's base level which brought about channel incision in the lower portions of the watershed.

Flora In 1984, Dr. Robert Dorn, principal investigator for Mountain West Environmental Services, mapped these vegetation types Aquatic (rooted in water), Aspen, Barren, Alkali Sagebrush (low sage); Basin Big Sagebrush, Cottonwood, Disturbed, Grass/Forb, Mixed Timber, Mountain Big Sagebrush, Mountain Shrub, Saline, Wet Meadow, and Willow. The distribution of these types is controlled primarily by soil moisture and edaphic factors, but some types, like the Barren type occurring on ridgetops, are also wind-influenced. Vegetation was mapped in 1984 on aerial photographs that contained some distortion caused by camera angle, etc. The vegetation patterns were transferred by hand to 1:24000 scale USGS topographic maps. This map was ground-truthed by the Mr. George Jones with the Wyoming Nature Conservancy several years ago. Jones made minor changes to the Mountain West map and provided a copy to FOBU. Jones' version was sent to the NPS GIS Service Center in Albuquerque, NM, where it was digitized. An ArcView version is now available. The vegetation patterns still need minor adjustment; they do not perfectly overlie the vegetation patterns seen on identically scaled digital orthographic photographs.

Three sagebrush communities dominate the landscape. The Basin Big Sagebrush type occurs below approximately 2,195 meters (7200 feet) on sites with deep, loamy, fertile soils. It is dominated by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), bluegrasses (*Poa spp.*) and wheatgrasses (*Elymus* spp.) The Mountain Big Sagebrush type, dominated by mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) occupies sites above 2,195 meters (7200 feet) having characteristics similar to sites supporting the Basin Big Sagebrush type. Various wheatgrasses, bluegrasses, and forbs are present in the understory. The Alkali Sagebrush type, dominated by low sagebrush (*A. arbuscula*) occurs on deep, clay soils at all elevations. This type occurs on soils with higher salinity and alkalinity than the other sagebrush types.

The Aspen type occurs on mesic sites in these scenarios along the base of Cundick Ridge and in valleys below springs and seeps, below ridges where the prevailing west wind causes snow accumulation during winters with average (or more) snowfall and wind, and on north-facing slopes which remain in shadow throughout much of the day. The Aspen type is dominated by aspen trees (*Populus tremuloides*).

Mixed Timber occurs primarily on steep north-facing and east-facing slopes where soils are shallow, and often calcareous. Limber pine (*Pinus flexilis*), Douglas fir (*Pseudotusuga menziesii*), and aspen dominate the Mixed Timber type. Mountain Shrub occurs on sites similar to those that support Mixed Timber. It appears to be a successional precursor to the Mixed Timber type because it sometimes dominates burned areas that once supported stands of Aspen and Mixed Timber types. Also, conifer seedlings can be seen in many areas currently supporting Mountain Shrub communities. Mountain mahogany (*Cercocarpos montanus*), Utah serviceberry (*Amelanchier utahensis*), and mountain snowberry (*Symphoricarops oreophilus*) are the dominant shrubs in the Mountain Shrub type.

The Grass/Forb type is dominated by Sandberg bluegrass (*Poa. sandbergii*), but indian ricegrass *(Stipa hymenoides*) and wheatgrasses are also present. Common forbs include stemless goldenweed (*Haplopappus acaulis*), Hoods phlox (*Phlox hoodii*), and starveling milkvetch (*Astragalus jejenus)*. This type thrives on drier sites in shallow soil, such as rocky ridges. The Grass/Forb type also exists where fire destroyed shrubby vegetation types. Rock outcrops, and barren windswept ridges were mapped as the Barren type. Some areas are totally devoid of vegetation; others support widely-spaced cushion plants, grasses, and forbs such as tufted twinpod (*Physaria condensata*).

The Wet Meadow type is dominated by Baltic rush (*Juncus balticus*), and sedge species (*Carex spp.*). Many other forb and grass species are present in the Wet Meadow community. Silver sagebrush (*Artemisia cana*) dominates drier sites, and willow species (*Salix spp.*) sometimes occur in more mesic sites. The Cottonwood and Willow vegetation types occupy, at most, a few acres where seepage, or artesian springs keep the soil wet. The Saline type is dominated by black greasewood (*Sarcobatus vermiculatus*) and Gardners saltbush (*Atriplex gardneri*).

Fauna More than 100 species of birds, mammals, snakes, and amphibians have been documented. Probably only the list of large mammals approaches the 90% level of completeness. Reptiles and amphibians are uncommon; only 5 species have been documented. One or two fish species enter during the brief period Chicken Creek is flowing. Fry and fingerlings have been observed in ephemeral pools near the boundary, but they have not been identified.

Pronghorn, jackrabbits, least chipmunks, and Richardson ground squirrels are probably the mammals most often seen. A variety of songbirds are present, and kestrels, northern harriers, red-tail hawks, and golden eagles are common summer residents.

Ungulates The Monument was grazed (and overgrazed) by domestic livestock for approximately 100 years. In 1990, livestock grazing discontinued. The affect of livestock

grazing remains unquantified, but Beetle and Marlow (1974), and Dorn, Lichvar, and Dorn (1984) made the following generalizations:

- the Monument was grazed during most of the year, primarily by sheep prior to 1973;
- improper placement of mineral blocks concentrated cattle on riparian areas;
- most recently the grazing allotment was 1166 animal unit months (AUMs);
- since livestock movement was uncontrolled prior to 1977 grazing may have exceeded the allotment of 1166 AUMs;
- grazing probably decreased the amount of perennial grasses;
- grazing probably increased the number and variety of annual plants; and
- grazing probably increased soil compaction and accelerated soil erosion.

Mule deer (*Odocoileus hemionus*), and a few moose (*Alces alces*) reside throughout the year. Elk are seen occasionally in summer and a few may reside throughout the year. More Mule deer migrate onto the Monument during the fall, and early winter, and they remain until late spring, leaving as land north of the Monument becomes snow-free. A herd of more than 100 elk (*Cervus elaphus*) spends part of the winter on the Monument. Elk use appears to be increasing, and this could become a problem. Pronghorn are commonly seen from late spring into late fall or early winter. Pronghorn usually migrate to wintering areas outside the Monument as soon as the snowpack be accumulates in late fall or early winter.

Mule deer, elk, and moose appear to be over-browsing some shrub communities, especially the Mountain Shrub type, and the few stands of willow and red osier dogwood (*Cornus sericea*). Based on the type and amount of scat observed, deer and moose use Mountain Shrub habitat more than elk. Moose are responsible for damage observed in willow and red osier dogwood.

Riparian and Aquatic Habitats Riparian and aquatic habitats of limited size occur at FOBU. There are sufficient perennial sources in and around FOBU that large native ungulates move about quite freely. Their distribution is probably affected to some degree by water availability, but to what extent remains uncertain. Domestic livestock, especially cattle, stay near water, and they damage riparian and aquatic plant communities. This extent of this impact was never quantified.

In a wet year, standing and flowing water covers no more than 1-2% (percentage only a rough estimate). Three valleys (Millet Canyon, Murder Hill Canyon, and Moosebones Canyon) and the headwater area of Chicken Creek immediately downstream of Spring #1 have had, or currently have, small populations of beaver. At present, only Millet Canyon, and the area below Spring #1 have significant beaver activity. Most of the aspen near water in the other beaver activity areas have been felled, and, at most, only one or two beaver live in those areas. The majority of aquatic habitat was created by beaver, but land slumping has created a few additional ephemeral ponds which support aquatic vegetation during part of the year.

Even where there is beaver activity and a perennial source of water, the water supply is insufficient to maintain all the ponds throughout summer even in the wettest years. The majority of slump ponds also dry up by mid-summer or earlier. These ponds support

several species of emergent vegetation, such as the common cattail (*Typha latifolia*), but they do not support a rich variety of submergent aquatic vegetation.

Ephemeral ponds may actually be detrimental to FOBU's population of amphibians, including the northern leopard frog, which is a species of management concern, because ponds frequently dry up before the larval amphibians can live out of water. Even when ponds do not dry up completely, low water levels have been observed to concentrate tadpoles, making them easy targets for predatory birds.

Several locations supported beaver in the past where there is no water today. Intermittent springs probably supplied water to these locations in the past, and they are expected to flow again if above normal precipitation occurs for several consecutive years.

Unique Features and Species of Special Concern

Plants None of the vegetation types are believed to be unique; however, management has special concerns regarding several vegetation types. Tufted twinpod (*Physaria condensata*) and starveling milkvetch (*Astragalus jejunus* Wats. var. *jejunus*) are considered imperiled globally and within Wyoming because distribution is limited (Wyoming Natural Diversity Database 1994), but they are not on the Fish and Wildlife Service endangered list. The largest populations are in the Barren and Grass/forb plant communities. Dorn's twinpod (*P. dornii),* which resembles tufted twinpod, was being considered for inclusion in the endangered species list in 1994. Dorn's twinpod occurs immediately west of FOBU, but its occurrence inside the park remains unproven.

Large ungulates appear to be over-utilizing the Mountain Shrub community at many localities. Mountain mahogany and antelope bitterbrush (*Purshia tridentata*), in particular, have many "clubbed" branches because most new growth has been removed by browsing for many years. Shrubs in this vegetation type already are, or are becoming, senescent. Ungulate over-browsing in the Mountain Shrub community is a management concern.

Invasive exotic plants are a management concern. Presently, at least 53 exotic plant species have been discovered growing inside the boundary. Introduced plants account for nearly 10% of species. Some exotic species are designated "noxious weeds" which must be controlled by landowners. Presently, FOBU controls Canada thistle (*Circium arvense*), bull thistle (*C. vulgare*), musk thistle (*Carduus nutans*), mullein (*Verbascum thapus*), common burdock (*Arctium minus*), spotted knapweed (*Centaurea maculosa*), perennial sowthistle (*Sonchus uliginosus*), houndstongue (*Cynglossum officinale*), white sweetclover (*Melilotus albus*), yellow sweetclover (*Melilotus officinalis*), black henbane (*Hyoscyamus niger*), and miscellaneous other introduced species encountered while spraying.

Mammals A list of mammal species of special concern include fringed myotis (*Myotis thysanodes),* spotted bat (*Enderma maculatum*), Townsend's big-eared bat (*Plecotus townsendii*), Idaho pocket gopher (*Thomys idahoensis*), white tailed prairie dog, Great Basin pocket mouse, pygmy rabbit, and mountain lion (*Felis concolor*). Some of these may not occur at FOBU.

Birds The avian species of management concern are golden eagle (*Aquilla chrysaetos*) and sage grouse.

Amphibians The northern leopard frog (*Rana pipiens pipiens*).

Second Priority Organisms Many organisms on this list could potentially alter vegetation, or imbalance predator/prey relationships; other species are believed to have diminishing populations include moose, elk, pronghorn, beaver, badger, mule deer, bobcat, northern harrier, short-eared owl (*Asio flammeus*), black-billed magpie, mountain bluebird, prairie falcon, red-tailed hawk, Swainson's hawk, ferruginous hawk, and American kestrel.

GOLDEN SPIKE NATIONAL HISTORIC SITE (GOSP)
Size 1,107 hectares (2,735 acres)

Park Legislative History The establishment of Golden Spike National Historic Site followed a 20-year effort by local citizens who believed the spot where the transcontinental railroad was completed on May 10, 1869 had tremendous historical significance. The original site which consisted of approximately 3 hectares (7 acres) around the Promontory town-site, was designated as a National Historic Site on April 2, 1957. However, initial designation was in non-Federal ownership. Thus, the Site existed in name only and lacked a protected land-base, staffing, and NPS administration. Subsequently, Public Law 89-102, signed into law July 30, 1965, set aside such lands as necessary "for the purpose of establishing a national historic site commemorating the completion of the first transcontinental railroad across the United States." This law provided for an authorized boundary, staffing, a development authorization, and oversight and management by the NPS. At this time, the Historic Site extended over 25 kilometers (15.5 miles) of original railroad grades and consisted of 892 hectares (2,203 acres).

Following the completion of a general management plan for the Historic Site in 1978 (NPS 1978), boundaries were expanded by an act of Congress on September 8, 1980. This public law expanded the boundary by 215 hectares (532 acres), though none of these additional lands have been acquired.

Park Mission and Purpose Mission statement from the 2000-2005 Strategic Plan for the Historic Site (NPS 1997b):

Golden Spike National Historic Site was established to commemorate the construction and completion of the first transcontinental railroad, and its tremendous historical consequences for our nation.

Dedicated to commemorating this historic work, Golden Spike National Historic Site preserves and interprets historic resources and values for the enjoyment, education, and inspiration of this and future generations.

The following three purpose statements further articulate the legislative intent and the fundamental reasons for the existence of Golden Spike National Historic Site:

- To commemorate the completion of the first transcontinental railroad across the United States as a public national memorial.
- To preserve the resources, historic sites, and knowledge for public use, enjoyment, education, inspiration, appreciation, and benefit.
- To provide and maintain markers, buildings, facilities and other improvements for the care and accommodation of visitors.

Building on these statements of purpose, significance statements for Golden Spike National Historic Site have also been developed and refined in the 1997 Comprehensive Interpretive Plan for Golden Spike National Historic Site. This effort produced 18 significance statements that summarize and capture the essence of Golden Spike National Historic Site's importance to our cultural and natural heritage.

Park and Area Description Golden Spike National Historic Site currently has 18 NPS employees and an annual operating budget of $650,000 for Fiscal Year 2001. Annual visitation to the Historic Site has ranged from 48,000 to 64,000 in recent years.

Presently, GOSP extends over 25 kilometers (15.5 miles) of original railroad grades and consists of 1,107 hectares (2,735 acres). Much of this acreage is contained within a 400-foot wide right-of-way obtained from the Southern Pacific Railroad. Of the total acreage, 895 hectares (2211 acres) are in Federal ownership, and 212 hectares (525 acres) remain in private ownership.

The Historic Site can be divided into three major areas of historical interest, The Summit, the East Slope, and the West Slope.

The Summit At Promontory Summit on May 10, 1869, the final spike was driven to complete the nation's first transcontinental railroad. This is the point where the Central Pacific Railroad from Sacramento, California, and the Union Pacific Railroad from Omaha, Nebraska, joined, making cross-country rail travel a reality. Only traces of these first railroad grades remain. By May 1, 1869, anticipating the joining of the rails, the summit tent-village of Promontory was born. It subsequently survived as a small railroad-support town until 1942. Archeological investigation yielded many traces of Promontory's occupation and use. Some time between 1916 and 1919, the Southern Pacific Railroad erected a monument in the area where the railroads first met. A plaque, added to the monument in 1958, indicates the area is a National Historic Site. After being moved on two occasions, this monument now stands just east of the visitor center.

The East Slope Spectacular remains reflecting railroad building and maintenance stretch across the Promontory Range from its eastern base at Blue Creek to the summit. These consist of Union Pacific and Central Pacific parallel grades; parallel rock cuts, including the Union Pacific's "false cut" just west of the Big Trestle/Big Fill area; Union Pacific trestle footings; major Central Pacific earth fills; stone culverts; a number of former-trestle locations; and two wooden trestles. The grades, cuts, fills, and trestle footings represent nearly every variety of the heavy work undertaken by the railroad workers except tunneling. Drill marks are visible in rock cuts, and borrow pits remain beside railroad grades. The basal portions of telegraph poles march up the east slope of the Promontories on the historic Union Pacific grade. Numerous stone foundations and rock walls, leveled tent platforms, remains of pit houses, dugouts and basements, fireplace chimneys, and hearth areas parallel the railroad grades on the east slope of the mountains. These indicate railroad construction worker camps, workshop areas (such as black-smithing), and one of the "Hell-on-Wheels" towns associated with the final days of construction (Camp Deadfall).

The West Slope From the summit area southwest, the parallel grades follow the gently sloping floor of Promontory Summit. This segment of the park includes a 5 kilometer (3.2 mile) portion of the grade on which the Central Pacific laid its renowned "ten miles of track in one day" and those portions of the Union Pacific grade that were never

completed or used. When the April 1869 order establishing Promontory Summit as the meeting point came, all Union Pacific work to the west stopped. The incomplete rock cuts, partially built fills, uncovered culverts, and unfinished grade provide excellent examples of railroad construction processes, such as the stockpiling and reuse of size-graded stone material for grade foundation and the stair-step type of construction undertaken at the long rock cuts. Drill marks, stone culverts, and wooden box and stave culverts also occur along the west slope. Like the eastern slope of the mountains, the western slope contains spectacular evidence of construction worker campsites such as pit house remains, lean-to shelters, rock walls, trash pits, and rock chimneys perched against prominent limestone outcrops.

Location In Northern Utah, 52 kilometers (32 miles) west of Brigham City, 86 kilometers (55 miles) north of Ogden, and 145 kilometers (90 miles) north of Salt Lake City in Box Elder County.

Elevation Elevations range from 1,329 meters (4,360 feet) to 1,609 meters (5,280 feet).

General Description GOSP contains hillsides, mountains, and plains at the summit of the Promontory Range in the northern basin of the Great Salt Lake and is in the Upper Sonoran Life Zone. The Historic Site lies in the northeastern reaches of the semiarid Great Basin Desert.

GOSP lies between the North Promontory and the Promontory Mountains in the northern part of the Great Salt Lake basin. During glacial times the summit was under ancient Lake Bonneville. As a result, old lake terraces form prominent features. Today's surface materials consist of fine-grained lake sediments and alluvial detritus. Subsurface deposits consist primarily of Pennsylvania sandstone, shales and limestones, and Tertiary extrusive materials. Numerous fault lines dating from the latter time run through the Promontory range. Minor earth tremors (2.5 to 4.0 on the Richter Scale) have been reported in the vicinity fairly often since 1965. No springs or travertine deposits occur although such features are found at Rozel Point, 24 kilometers (15 miles) to the southwest of Promontory. Also, at Rozel Point is an asphalt seep that was discovered before the first organized oil exploration in the early 1900s.

Annual precipitation averages 203 to 305 millimeters (8 to 12 inches), mostly as snow. Temperatures range from highs of 20 degrees in winter to an occasional 104 degrees in summer. July and August are the hot months, while the coldest weather is from late December through February. Winter nights are typically below 10 degrees Fahrenheit. Spring and autumn months are generally mild, although vary widely from day to day.

Snow depths vary considerably, but average less than 305 to 356 millimeters (12 to 14 inches), with occasionally 152 to 203 millimeters (6 to 8 inches) falling per storm. Historical records for Promontory indicate that one snowfall of 94 centimeters (37 inches) in the late 1940s.

Flash floods from occasional severe storms and spring runoff, aggravated by adjacent agriculture land use, cause erosion of historic grades, cuts, fills, and trestles. As a result, the Historic Grade and associated features have been damaged. Yet damage also occurs on a

more gradual basis from natural erosion. Over the years water erosion deterioration has been documented at Trestles Number 1 and 2. Also, water erosion has impacted the east slope of the grade below a concrete box culvert west of these trestles. And the loss of a segment of the Union Pacific grade 2 kilometers (1 mile) east of the visitor center was a serious preservation problem because of water erosion, but seems to have been alleviated with the installation of water control gabians. Flooding between the visitor center and Kings Pass was a serious problem in 1983. Severe erosion occurred at the burned-out-trestle, but this area has stabilized with the installation of water control gabians.

Thunderstorms also concentrate lightning strikes on the Promontory Mountains and salt flats near the west end, creating serious rangeland fire potential. Occasional prolonged windy conditions in this semiarid rangeland hasten the weathering of facilities and equipment.

Flora Today the region is semiarid to arid and is included in the shad scale-kangaroo-rat-sagebrush biome of the northern Great Basin. The major flora consists of sagebrush (*Artemisia tridentata*), rabbit brush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), Indian rice grass (*Stipa hymenoides*) and a variety of other grasses. A few Utah Junipers and one historic box-elder tree grow on park lands. Non-native vegetation includes tumble mustard, cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron desertorum*), and other species.

The vegetation is different from what existed 130 years ago at Promontory Summit. There is a much greater concentration of non-native species and noxious weeds. As a result, the vegetative landscape has changed in GOSP as well as on adjacent lands. However, the visual appearance of vegetative changes does not appear to have significantly altered the cultural landscape.

The Passey Onion (*Allium passeyi)* has been located on a rocky knoll on the east slope. It occurs only in Box Elder County and is a candidate species for future study and possible inclusion on the list of rare plants. There is no known plant or animal species listed as rare or endangered.

Fauna Wildlife is varied and consists of larger mammals such as the coyote, mule deer, bobcat, badger, and jackrabbit. There are also smaller mammals, reptiles, insects, and numerous bird species. Large numbers of raptors inhabit the area. Accipiters, falcons, buteos, and golden and bald eagles are particularly common during winter months.

Aquatic Features Except for the Blue Creek, which bisects the northeastern end, water is not available in stream or spring. The park receives water from a well (130 meters/427 feet deep) at the summit. Water is scarce in this semiarid region, which accounts for sparse population. The water scarcity has not affected operations at present visitation levels.

Description of Cultural Resources

GOSP was administratively listed on the National Register of Historic Places in 1966. The National Register of Historic Places registration form was approved by the Utah State Historic Preservation Office and submitted to the Keeper of the National Register in

1987. Additionally, in 1969, the historic railroad grade was designated as a National Civil Engineering Landmark.

Presently, cultural resources at GOSP can be best organized in the following categories identified in NPS-28, Cultural Resources Management Guidelines (NPS 1999b).

Historic Structures Beginning in 1995, a comprehensive Grade Resources Study was initiated by Historic Architect A. Sayre Hutchison and Chief Ranger Rick Wilson. This effort is well underway and will ultimately result in the preparation of a historic structures report. In 1996 and again in 1998 and 2000, the List of Classified Structures for the Historic Site was updated. It presently identifies 37 separate structures (though more will be added following an inventory of vanishing treasures resources). The majority of structures currently listed are historic railroad culverts. Two railroad trestles are listed and also the grades themselves. The Last Spike Site is listed as a composite structure, though the white obelisk is listed separately. At least three archeological structures, related to initial railroad construction, have significant standing walls and are identified on the List of Classified Structures.

Archeological Resources Archeological resources have been identified and documented in three primary efforts. Between 1974 and 1978, Archeologist Adrienne Anderson completed a reconnaissance level inventory, mapping 340 separate features. These resources were grouped into 16 sites and were identified on 13-sheet series of maps, entitled *Cultural Resources Bases Map* (1978). Between 1976 and 1982, James E. Ayers completed a more-detailed inventory of archeological resources around Promontory. This work led to the 1982 report: *Archeological Survey of Golden Spike National Historic Site and Record Search for Promontory, Utah*. More recently, between 1995 and 1999, Byron Knudson compiled documentation on archeological features (his work has resulted in the discovery of numerous additional features and the reclassification of site boundaries). This effort has resulted in the documentation of 332 features. Beginning in 1999, the Historic Site was funded for a complete survey, and this project is underway.

Cultural Landscape In 2000 a cultural landscape inventory was completed (Homstad, Caywood and Nelson 2000) . This work confirmed the existence of a cultural landscape. A cultural landscape inventory and a cultural landscape report exist.

Museum Objects The Historic Site has 9,762 objects in its collection. A Scope of Collections Statement was approved in 1988 and needs to be updated. A review of archives was completed, but additional archival survey work and evaluation is needed.

Historic Studies The following historic studies are complete: 1960 *Special Report on Promontory Summit, Utah (Golden Spike National Historic Site);* 1969 *Historical Base Map, 1869, Golden Spike National Historic Site, Utah;* 1989 *Promontory Station, An Industrial Outpost in the American West;* 1996 *The Development of Golden Spike National Historic Site: A History of its Creation.*

Ethnographic Resources GOSP is in the midst of the Fremont-Promontory prehistoric culture group area. The Paiutes were here when the region was first settled by Anglos.

Currently, four American Indian tribes have some level of association or linkage to GOSP lands including the Paiute Indian Tribes of Utah Tribal Council, the Shoshone-Bannock (Fort Hall Business Council), the Skull Valley Goshute General Council, and the Uintah & Ouray Tribal Business Committee.

Interrelationship Between Management of Cultural and Natural Resources

Many resource management activities involve both cultural and natural resources.

- Management of the cultural landscape involves the cultural imprint on the natural landscape.
- A major objective of the fire management program is to re-establish natural vegetation regimens and reduce sagebrush, which covered less ground in 1869. Sagebrush is responsible for long-term degradation of cultural features. Aerial photographs from 1938 to the present also indicate vegetation changes.
- Preservation of grade resources is related to hydrologic runoff during storm events, effective erosion control, natural deterioration, and vegetation root systems.
- Many historic photographs show natural landscape features such as hillsides, mountain peaks, and vegetation along with human-built features such as tracks, construction materials, trails, and structures.
- Location of archeological sites is highly related to geologic terrain.

HOVENWEEP NATIONAL MONUMENT (HOVE)
Size 318 hectares (785 acres)

Park History and Purpose Hovenweep National Monument was first established by Warren G. Harding in 1923 by Presidential Proclamation 1654 (42 Statute 2299). The Proclamation states in part, "Whereas, there are in southwestern Colorado and southeastern Utah four groups of ruins, including prehistoric structures, the majority of which belong to unique types not found in other National Monument's, and show the finest prehistoric masonry in the United States; and…It appears that the public good would be promoted by preserving these prehistoric remains as a National Monument with as much land as may be necessary for the proper protection thereof…that there is hereby preserved, subject to prior valid claims and set apart as a National Monument to be known as Hovenweep National Monument…"

Subsequent Presidential Proclamations 2924, April 29, 1951; 2998, November 20, 1952, 3132, April 6, 1956; and Public Land Order 2604, February 5,1962, added other areas and adjusted boundaries. Given the proclamations listed above and the Organic Act of August 25, 1916 (Public Law 235, 39 Stat. 535) the NPS mandate is to preserve and protect the cultural and natural resources associated with the six ruin groups, and to assist visitors in understanding the life and culture of the prehistoric inhabitants and their environmental adaptations.

Hovenweep's resource values consist of significant cultural resources and their associated pristine natural settings. The Cajon, Square Tower, Holly, Hackberry/Horseshoe, and Cutthroat units contain clusters of Ancestral Puobloans pueblos and towers situated near permanent springs at canyonhead locations on Cajon Mesa. These canyon rim towers and villages are the best preserved and protected, most visually striking, and accessible examples of 13th century Ancestral Puebloan architecture and community locations within the San Juan River Basin. Other archeological sites representative of Paleo–Indian, Archaic, and early Puebloan occupation are also found. These five units are significant because of they possess a high degree of physical and locational integrity. In addition, the towers are noteworthy because of many stylistic variations.

The Goodman Point unit consists of an immense, unexcavated pueblo in the Montezuma Valley. These remains reflect its position as a regional center for the Mesa Verde Ancestral puebloans, and it is the one of the best-preserved sites in the West. It is the first archeological site set aside by the Federal government, on September 13, 1889, and represents one of the largest 13th century villages in the San Juan Basin. These villages contain elements of public architecture such as great kivas, plazas, reservoirs, enclosing walls, etc. Hovenweep also contains some of the best examples in the nation of ancient astronomical calendars that mark important seasonal events using architecture, rock art, and sunlight.

Location HOVE contains six distinct units situated in the Four Corners area. The Square Tower and Cajon units are located in San Juan County, Utah. The Goodman Point,

Hackberry/Horseshoe, Holly, and Cutthroat units are located in Montezuma County, Colorado.

Elevation Elevation varies from 1,585 meters (5,200 feet) at the Cajon unit to 2,060 meters (6,760 feet) at the Goodman point unit.

General Description The natural environment is characterized by rugged topography, with small canyons divided by narrow mesa tops. The primary geologic formation is Cretaceous Dakota sandstone. Shallow to deep aeolian soils are found on the mesa tops, with shallow colluvium on canyon slopes, and shallow to deep alluvium in canyon bottoms. While permanent water sources are limited, a few springs and seeps in canyonheads produce water year-round. Residual water trapped in potholes or flowing in washes after rains or snowmelt is seasonally available.

Five of Hovenweep's six units are on Cajon Mesa, which covers approximately 500 square miles on the Colorado-Utah border near Four Corners. Although topography is fairly uniform, variations in rainfall, soil type, and plant associations occur through minor elevation and drainage pattern differences. The northern half of the mesa is higher, cooler, and wetter supporting a pinyon-juniper forest. This part of the mesa is the most productive today, growing dry land pinto beans, winter wheat, and alfalfa. Most HOVE units are in the juniper-sage and sage in the mesa's mid-section.

The climate in this high desert is dry, with an average of 305 millimeters (12 inches) of precipitation per year. Temperatures range from winter lows of –10 to 0 degrees F to summer highs averaging 100 to 105 degrees F, with a mean annual temperature of 52 degrees F.

Flora HOVE contains about 320 vascular plant taxa. Vegetation zones range from shrubland to mixed sage and juniper woodland to pinyon juniper forest. Riparian communities exist. A thorough plant survey occurred in 2000.

From the early 1900s through the 1940s all of HOVE was subjected to heavy sheep grazing eliminating much of the ground cover. Vegetation depletion was followed by soil loss through erosion. Thus, soils are thin and species composition poor. Fortunately, exotic species have not had a significant impact.

Most HOVE units are in the juniper-sage and sage in the mesa's midportion. In addition to the above plants, rabbitbrush, cliffrose, Mormon tea, yucca, and serviceberry are common and were important plants to prehistoric Ancestral Puebloans. It was most heavily occupied by ancient people when they built the settlements preserved at HOVE.

Permanent seeps and springs are common in canyonheads that cut the mesa, especially at the point of contact between the porous Dakota Sandstone that caps the mesa and the underlying, more impervious Morrison Shales. The seasonal and permanent springs in the canyonheads are important sources of springtime moisture.

South of Square Tower Unit sagebrush blends into mixed-shrubland plant zone composed of shadscale, greasewood, snakeweed, and grasses. This zone covers the southern end of

Cajon Mesa and the San Juan River Valley. In some places snakeweed is dominant, especially in overgrazed areas. The Cajon Unit is the only part in this plant zone.

The Goodman Point unit lies a few miles northwest of Cortez, Colorado at a higher elevation, receives more moisture, and has slightly cooler temperatures than other units. The environment is pinyon-juniper forest, surrounded by modern dry farmland producing pinto beans and winter wheat. Parts of Goodman Point unit are almost completely overgrown with a vigorous sage. The unit contains a large spring.

Fauna Over 150 species of mammals, birds, reptiles, amphibians. Common mammals include mule deer, bobcat, mountain lion, and coyotes. Birds are most numerous in cottonwood and willow vegetation along streams and perennial water sources. The Gunnison sage grouse, a sensitive species, has been observed. Reptiles are found throughout. The most common lizards are the side-blotched and sagebrush lizards, and the most common snakes are gopher snake, western rattlesnake, and striped whipsnake. Amphibians are not common, found only near streams, springs, and rock pools. There are no fish.

Aquatic Features Very little aquatic activity is noted. Macroinvertebrates are monitored 4 times a year as part of the Water Quality Monitoring Program started in 1999. Tiger salamanders (*Ambystoma tigrinum* var. *nebulosum*) have been observed at some springs.

Unique Features and Species of Special Concern
Plants HOVE may contain plants of concern. Cronquist's milkvetch (*Astragalus cronquistii*), Naturita milkvetch (*Astragalus naturitensis*), and cut-leaf gumweed (*Grindelia laciniata*) are reported in the general area but have not been found within the monument.

Animals The Gunnison sage grouse (*Centrocercus urophasianus gunnisonii*), a sensitive species, has been sighted. Mexican spotted owls (*Strix occidentalis lucida*) and southwestern willow flycatchers (*Empidonax traillii extimus*) could be found once surveys begin.

Resource Management Concerns
Trespass livestock and exotic plant species are main resource management concerns.

Recreation Use Visitor use increased rapidly during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off-trail destroy crytobiotic soils and tramples vegetation, which increases erosion.

Land Use Impacts Agricultural practices surrounding the monument, primarily livestock grazing, are a concern. While the number of livestock that trespass is low, vegetation is damaged and lost through trampling and consumption, and invasive weeds are introduced. Energy resource exploration and extraction is increasing. Around the monument are deposits of oil, natural gas, uranium, vanadium, coal, and pure carbon dioxide. These activities could negatively affect some resources such as water availability and soil contamination. Sound pollution is also a problem from the mining activity. Air pollution has increased in the past 40 years due to coal burning power plants.

Invasive Exotic Plant Species There are 27 exotic plant species. The monument is surrounded by agricultural lands and the exotic plant source is high and constant. Tamarisk (*Tamarix ramosissima*) has invaded canyon bottoms in all units but most has been controlled through mechanical cutting and herbicide.

NATURAL BRIDGES NATIONAL MONUMENT (NABR)
Size 3,009 hectares (7,435 acres)

Park History and Purpose Established in 1908, Natural Bridges National Monument is Utah's oldest National Park. A total of 49 hectares (120 acres) were originally set aside around each of three bridges based on President Theodore Roosevelt's original Proclamation No. 804, April 16, 1908, 35 Statute 2183. The main purpose was stated as, "Whereas, a number of natural bridges situated in southeastern Utah having heights more lofty and spans far greater than any heretofore known to exist, are of the greatest scientific interest, and it appears that the public interests would be promoted by reserving these extraordinary examples of stream erosion with as much land as may be necessary for the proper protection thereof..."

Later, the Monument was enlarged to 979 hectares (2,420 acres) containing the three bridges, prehistoric structures, and cave springs, as stated in President William H. Taft's Proclamation No. 881, September 25, 1909, 36 Statute 2502, "...at the time this Monument was created nothing was known of the location and character of the prehistoric ruins in the vicinity of the bridges, nor of the location of the bridges and prehistoric cave springs, also hereby reserved..."

The same area was resurveyed, and set aside by President Woodrow Wilson's Proclamation No. 1323, February 11, 1916, 39 Statute 1764, "...whose purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

In August 1962, President John F. Kennedy's Proclamation No. 320 withdrew 320 acres around Snow Flat Spring Cave and Cigarette Spring Cave since these caves, "...no longer contain features of archeological value and are not needed for the proper care, management, protection, interpretation, and preservation of the Monument." This proclamation expanded the Monument, reiterated the public and scientific communities' interest in preservation and protection of the bridges and prehistoric sites, and set forth management objectives.

Location In San Juan County, Utah, 193 kilometers (120 miles) south of Moab, Utah, accessible via Utah Highway 95, which connects Blanding, Utah with Hanksville, Utah. Blanding, Utah (population 3,100) is the nearest population center, located 64 kilometers (40 miles) east. The surrounding area (San Juan County) is sparsely populated, with a density of less than 1.5 people per square mile (0.6 people per square kilometer). The surrounding area has never been settled by Anglos and has been used only for extensive livestock grazing and minor mining activities.

Elevation Elevation varies from approximately 1,738 meters (5,700 feet) in the canyons to 1,951 meters (6,400 feet) on the rims.

General Description Nowhere else are three such extraordinary natural bridges found in such close proximity. These three bridges show three different stages of development from

youth (Kachina), to maturity (Sipapu), to old age (Owachomo). Together with their canyons, these three bridges are excellent examples of an entrenched meander stream system.

NABR was also created for the presence of three well-preserved structural sites and a range of archaeological sites from Archaic through historic times.

A high desert riparian environment combined with a year-round supply of standing water (the result of numerous seeps) creates a unique biological climate where relict species (Douglas fir) remain and moist alcoves shelter hanging garden communities. Here rare plants (such as the kachina daisy) find refuge, and other water-loving flora thrive in riparian corridors that provide food, shelter, and travel for wildlife. NABR provides a breeding ground for peregrine falcons, is home to at least 15 bat species, and is surrounded by extensive public lands that are candidates for Wilderness designation.

Pristine air quality ensures extensive vistas and, combined with the absence of artificial light, provides outstanding opportunities to view night skies. The absence of human-generated sound leaves visitors to enjoy natural silence, a hallmark of canyon country.

NABR was also established to preserve outstanding Ancestral Puebloan cultural remains. Cultural resources o are outstanding and provide the opportunity to study interactions among indigenous cultural groups. Numerous sites exist with religious and historical significance to American Indians.

NABR preserves one of the few locations of the very rare kachina daisy (*Erigeron kachinensis*), and an outstanding example of an ephemeral desert stream. NABRs ecological processes and biological diversity are found in few other places.

NABR contains two major canyons, White and Armstrong, which are deeply incised into the Cedar Mesa sandstone. The vegetation is predominately pinyon-juniper woodland, a vegetation type common to most of southeast Utah at elevations of 1,220 to 2,440 meters (4,000 to 8,000 feet). Riparian vegetation occupies the surface water drainages, and small pockets of Douglas fir and associated mesic vegetation grow in sheltered areas along canyon rims. Common large mammals include mule deer, coyote and desert cottontail. Conspicuous birds are the common raven, turkey vulture, red-tailed hawk and scrub jay. A variety of lizards can be seen during the warmer months, along with a large population of midget prairie rattlesnakes.

Flora

NABR flora database contains approximately 437 species. Vegetation is divided into five communities.

Pinyon-Juniper Community

This community is the most extensive vegetation type, covering approximately 1,700 hectares (4,200 acres), dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). Other major shrub components are broom snakeweed (*Gutierrezia sarothrae*), roundleaf buffaloberry (*Shepherdia rotundifolia*), big sagebrush *(Artemisia tridentata*), and prickly pear cactus (*Opuntia* spp.). Common forbs are twinpod (*Physaria*

acutifolia), lobeleaf groundsel (*Senecio multilobatus*), and Holboel rock cress (*Arabis holboellii*).

Rimrock Community
Next in coverage, this community accounts for 1,100 hectares (2,700 acres). The rimrock community is a shrub-dominated type found on the canyon rims and is of varied composition. Primary components are pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), manzanita (*Arctostaphylos. patula*), Gambel oak (*Quercus gambelii*), broom snakeweed (*Gutierrezia sarothrae*), Utah serviceberry (*Amelanchier utahensis*), longflower snowberry (*Symphoricarpos longifolius*), and Haplopappus (*Haplopappus* spp.) for roughly 160 hectares (400 acres). Riparian vegetation communities are dominated by Fremont cottonwood (*Populus fremontii*), western sandbar willow (*Salix exigua*), yellow willow (*S. lutea*), and box elder (*Acer negundo*). Of the many forbs and grasses principal species are phragmites (*Phragmites communis*), horsetail (*Equisitum arvense*) and (*E. laevigatum*), and hairy goldenaster (*Heterotheca villosa*).

Douglas Fir Relict Community
Encompassing less than 160 hectares (400 acres), the Douglas fir community is a relict community characterized by Douglas fir (*Pseudotsuga menziesii*), Utah serviceberry (*Amelanchier utahensis*), mountain lover (*Pachystima myrsinites*), dwarf mountain mahogany (*Cercocarpus intricatus*) and manzanita (*Arctostaphylos patula*).

Hanging Garden Community
The smallest vegetal component, covering less than 30 hectares (80 acres), the hanging garden vegetation type is characterized by moisture loving plants. These include maidenhair fern (*Adiantum capillus-veneris*), cliff-brake (*Pellaea* spp.), scarlet monkey flower (*Mimulus eastwoodiae*), death camus (*Zigadenus* spp.), columbine (*Aquilegia* spp.) and alcove bog-orchid (*Habenaria zothecina*).

Fauna
There are approximately 127 bird species, 68 mammal species, 17 reptile species, and 7 amphibian species. There are no fish.

Mammals
Mammals were systematically surveyed from 1987-1994. The most common mammals are the western pipistrel bat (*Pipistrellus hesperus*), coyote (*Canus latrans*), gray fox (*Urocyon cinereoargenteus*), white-tailed antelope squirrel (*Ammospermophilus leucurus*), Colorado chipmunk (*Eutamias quadrivittatus*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), pinyon mouse (*P. truei*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), and mule deer (*Odocoilus hemionus*). According to Mike Bogan of the USGS/BRD Albuquerque, Natural Bridges is a "hot spot" for bats on the Colorado Plateau. Of the 19 species thought to live in Utah, 15 have been captured in NABR (including the spotted bat, a candidate species for Federal listing). Mountain lion tracks are common; actual sightings are rare. Black bear occasion the canyons and rim, but they are rarely seen. Desert bighorn sheep were observed prior to 1966 when the loop road was constructed. They probably still roam sections of lower White Canyon and surrounding environs.

Birds
Common bird species are turkey vulture (*Cathartes aura*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*) American kestrel *(Falco sparverius)*, mourning dove (*Zenaidura macroura*), great horned owl (*Bubo virginianus*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis)*, ash-throated flycatcher (*Myiarchus cinerascens)*, violet-green swallow (*Tachycineta thalassina*), cliff swallow *(Hirunda pyrrhonta*), scrub jay (*Aphelocoma coerulescens*), pinyon jay (*Gymnorhinus cyanocephalos*), common raven (*Corvus corax*), plain titmouse (*Parus inornatus*), canyon wren (*Catherpes mexicanus*), and black-throated sparrow (*Amphispiza bilineata)*.

Annual bird surveys have been conducted since 1986. Two transects are monitored three times over the breeding season. Among species of concern are the peregrine falcon (one breeding pair has been successfully nesting since 1993), the bald eagle (occasionally seen, but not a resident), and the Mexican spotted owl (found in remote canyons nearby, but not in NABR). Brown-headed cowbirds (*Molothrus ater*) have been recorded.

Herptofauna
Common herptofauna are the red-spotted toad (*Bufo punctatus*), Woodhouse toad (*B. woodhousei*), Great Basin spadefoot toad (*Scaphiopus intermontanus*), tiger salamander (*Ambystoma tigrinum*), plateau striped whiptail (*Cnemidophoras velox*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciousus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), desert night lizard (*Xantusia vigilis*), side-blotched lizard (*Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis melanoleucus deserticola*), western terrestrial garter snake (*Thamnophis elegans vagrans*), and the midget prairie rattlesnake (*Crotalus viridis viridis*).

Aquatic Features Very little aquatic activity is noted except tadpoles and tiger salamanders. There are no fish. Macroinvertebrates are monitored 4 times a year as part of the Water Quality Monitoring Program started in 1997.

Unique Features and Species of Special Concern
<u>Plants</u> The rare kachina daisy (*Erigeron kachinensis*) is found in NABR. This species was first described from Natural Bridges and is uncommon throughout its range. The kachina daisy exists in several moist alcoves associated with hanging garden communities and has been the subject of extensive research by Allphin and Harper (1994). It is endemic to San Juan County, Utah and Montrose County, Colorado and has been recommended for high priority species-level management (Heil et al. 1993).

<u>Animals</u> Peregrine falcon (*Falco peregrinus*) has been delisted but is still of concern. A breeding pair has nested successfully since 1993. The aerie location has changed each breeding season, but has remained within a discrete area. The threatened Mexican spotted owl (*Strix occidentalis mexicana*) is known to occur in similar habitats near the Monument, but surveys have not revealed their presence here. A pair of northern goshawks (*Accipter gentilis*) nested in NABR in 1998.

Resource Management Concerns
Increased visitation, trespass livestock, and exotic plant species are resource management concerns.

Recreation Use Visitor use increased rapidly during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off-trail destroy crytobiotic soils and tramples vegetation, which increases erosion.

Land Use Impacts Agricultural practices surrounding NABR, primarily livestock grazing, are a concern. Trespass cattle are a constant problem. While lands are withdrawn from mineral leasing, oil and gas leases exist on BLM lands within 3 to 5 kilometers (2 to 3 miles) of the boundary (though none are currently in production), and there is increasing potential for oil and gas development within White Canyon. Oil and gas development is an external threat to NABR resources (clean air, night sky, solitude and wilderness).

Invasive Exotic Plant Species About 40 exotic plant species such as tamarisk, horehound mint, and musk thistle. The extent of spread has been minimized by staff who make a concerted effort to control exotics through mechanical and chemical means.

PIPE SPRING NATIONAL MONUMENT (PISP)
Size 16 hectares (40 acres)

Park Purpose and History Geologic processes produced these desert springs and made the site a focus for wildlife, and a centuries-long continuum of human habitation. The springs were well known to Ancestral Puebloan people and bands of Southern Paiutes long before the arrival of Mormon missionaries in 1858. Following the ill-fated homesteading efforts of James Whitmore, in 1870 the Mormon Church established a tithing ranch and constructed a fort (Winsor Castle) for protection from Indians.

Besides the business of ranching, Pipe Spring became an outpost for another church venture—the Deseret Telegraph. A spur line was established through Pipe Spring in 1871, creating the first telegraph station in the Arizona Territory. In 1909, the Kaibab Paiute Indian Reservation was established and surrounded Pipe Spring. But ranch buildings, springs, and grounds immediately around the springs remained in private ownership until transfer to the NPS in 1923.

Pipe Spring National Monument was established by President Warren G. Harding's proclamation No. 1663 (43 Stat. 1913) of May 31, 1923, “Whereas, it appears that the public good would be promoted by reserving the land on which Pipe Spring and the early dwelling place are located as a National Monument, with as much land as may be necessary for the proper protection thereof, to serve as a memorial of western pioneer life…”

The 1923 proclamation further addresses the spring water by clarifying that the availability of water at the site was one reason for its establishment as a monument, stating, “Whereas, there is in northwestern Arizona on the road between Zion National Park and the North Rim of the Grand Canyon National Park a spring, known as Pipe Spring, which affords the only water along the road between Hurricane, Utah, and Fredonia, Arizona, a distance of sixty-two miles…”

It also declares that, “in the administration of this Monument, the Indians of the Kaibab Reservation, shall have the privilege of utilizing waters from Pipe Spring for irrigation, stock watering and other purposes, under regulations to be prescribed by the Secretary of the Interior.” Although the proclamation does not speak to any other third party use of water, it does state that monument establishment is “subject to all prior valid claims.”

Throughout the early years, descendants and associates of former ranch owners were allowed to continue using water for livestock. Through those same years, the Indian Agent for the Kaibab Paiute Tribe pointed out that the Tribe’s use was precluded or made extremely difficult. As a result of disagreement between the cattlemen, the Indian Agent, and the monument custodian, in 1933, Assistant Secretary of the Interior, Oscar L. Chapman, signed a document titled “Regulations For The Division Of The Waters Of Pipe Springs” that states, “ The waters of the Springs shall be divided equally, one-third to the Pipe Springs National Monument, one-third to the Indians of the Kaibab Indian Reservation, and one-third to the stockmen represented by a memorandum agreement signed June 9, 1924, by representatives of the respective interests.”

In 1933, the flow of Tunnel Spring roughly approximated one-fifth of the total flow of all springs. As this presumably met the cattlemen's needs and as a matter of engineering convenience, the totality of Tunnel Spring flow was diverted to the cattlemen. After many years of discontent over water delivery to the Tribe, the National Park Service and Tribe entered into an agreement in 1972 whereby, in exchange for the Tribe's one-third of the spring flow, the NPS built and agreed to maintain a culinary water well and delivery system on reservation lands north of the Monument. The NPS pays the Tribe for its use of water from this system. This twenty-five year agreement expired in 1997. A rewritten agreement has been mutually drafted, but is yet to be effectuated. In the interim, the old agreement has been mutually renewed in three month increments.

From the Long Range Interpretive Plan (NPS 2000) and the most recent Statement for Management (NPS 1995b), the Mission and Purpose of Pipe Spring National Monument is:

Mission

The mission is to

- protect the natural and cultural resources in an unimpaired state for the enjoyment of the public,
- increase knowledge and understanding of, and convey the compelling stories of pioneer and American Indian culture, history, and relationships to the natural environment, and,
- protect the water of the springs to the greatest degree possible, yet allowing use as entitled by law.

Purpose

The purpose is to

- serve as a memorial of Western pioneer life, Kaibab Paiute culture, and interactions between Euro-American and Indian cultures,
- preserve and protect the springs and associated natural environment,
- preserve, protect, and develop a better understanding of the cultural significance and resources present at the site, and,
- provide opportunities for visitors to experience, understand, and enjoy the site.

Location A 16 hectare (40 acre) historic site in the northeast part of Mohave County, Arizona,16 kilometers (10 miles) south of the Arizona-Utah border, and entirely surrounded by the Kaibab-Paiute Indian Reservation. Primary access provided by Arizona State Highway 389.

Elevation Elevations range from 1500 meters (4923 feet) to 1555 meters (5100 feet).

General Description On the Moccasin Terrace of the Markagunt Plateau at the southern sloping base of the Vermilion Cliffs. From this site, a dry plain slopes southward for 48 kilometers (30 miles) before descending into Grand Canyon.

Culturally introduced plant materials include a variety of shade trees (ash, cottonwood, poplar, elm, locust, ailanthus), fruit trees, a grape arbor, and a vegetable garden. Temperatures highs range in the summer from 90 to 115 degrees Fahrenheit; in the winter, normal low temperatures range between 0 and 40 degrees Fahrenheit.

There are three springs, the main spring (Pipe Spring), emerging from beneath the fort itself, Tunnel Spring (located just southwest of the fort), and West Cabin spring (a seep spring once called the "calf-pasture spring"). The springs are fed by the Navajo Sandstone aquifer to the north and west, via the Sevier Fault. Only one spring, West Cabin, flows naturally, creating a very small riparian area (1/8 acre).

PISP also contains paleontological resources: three tridactyl dinosaur footprints, tentatively identified as *Eubrontes.* (Cuffey et al. 1998)

Unique Features and and Species of Special Concern
The most unique/important/critical natural (and cultural) resource is water. Prehistoric and historic American Indian people have used the spring waters for thousands of years. In the 1860s, the springs were claimed by Mormon pioneers and used for settlement and ranching purposes until 1923 when Pipe Spring was proclaimed a national monument and the ranch purchased.

As of the second week of June, 1999, the historic spring ceased to flow for the first time on record. This spring, located directly beneath the north building of Winsor Castle is divided into two flows—one which proceeds through a historic subsurface trench to an emergence point outside the Castle's west gate, known as Big Spring, and a second flow which is piped beneath the Castle courtyard into and through the Castle's Spring Room. The runoff from both Big Spring and the Spring Room feed historic masonry ponds immediately south of the Castle. Spring flow is critical to the historic integrity, and provides life-giving sustenance to acres of shade trees, a representative historic orchard, and wildlife.

As one of few perennial water sources on the Arizona Strip, the springs provide a vital resource for resident bird populations and are also vital to migrating bird populations. A bird inventory has been completed.

Water is important for all local fauna. Reptiles and small rodents are particularly abundant, as are bats. Complete inventories do not exist for any animal species.

The climate is fairly temperate, and the plant and animal species are typically semi-desert. North of PISP is pinyon-juniper woodland. Intermingled with and at the edge of this woodland community is a sagebrush grassland with sagebrush dominant on the more level areas of ground and pinyon-juniper occurring on the shallow rocky soils and broken country of adjacent higher elevations. Other on-site vegetation includes rabbitbrush, prickly pear cactus and sagebrush. Nearly half PISP contains the aforementioned semi-desert plant species. Animal species include small rodents, reptiles, birds, bats, amphibians, and coyotes.

Resource Management Concerns
While the main thrust is human history, there would be no human history here were it not for the natural resources. PISP has been an oasis and is critically important to wildlife, as well as migratory animals. With the exception of the bird study, a 70% complete plant

survey, and an aquatic invertebrates survey, no other survey data exists for the floral or faunal resources.

An important part of the story is the grazing lands (as well as the water) that attracted Euro-American pioneers to the Arizona Strip. Stories abound regarding “grass belly high to a horse.” Overgrazing reduced the range to dust by the 1890s, and what has managed to recover is mostly sage-salt bush desert scrub. A future resource management interpretation project will attempt to reseed with native grasses.

Exotic plant species such as puncture vine, cheat grass, alanthus, and Siberian elm trees are of concern. However, trees, along with silver-leafed cottonwoods, none of which are native, provide the only shade. Most trees were planted by the NPS. Efforts should be made to eliminate exotics, however, many shade trees in public areas will be retained.

TIMPANOGOS CAVE NATIONAL MONUMENT (TICA)
Size 101 hectares (250 acres)

Park Purpose and History Timpanogos Cave National Monument was established by Presidential Proclamation No. 1640, signed by President Warren G. Harding on October 14, 1922. The Proclamation reserved Timpanogos Cave due to its "unusual scientific interest and importance," stating that "the public interests will be promoted by reserving [the] cave with as much land as may be necessary for the proper protection thereof." At the time, the Timpanogos Cave system was within the Wasatch National Forest and managed by the U. S. Forest Service. The Proclamation clarifies the management differences between the Monument and the Forrest by stating that the reservation of land for the National Monument was "not intended to prevent the use of the lands for the National Forest purposes under the proclamation establishing the Wasatch National Forest, and the two reservations shall both be effective on the land withdrawn but the National Monument…shall be the dominant reservation."

Executive Order No. 6166, dated June 10, 1933, placed all national monuments under the jurisdiction of the Department of the Interior. On July 1, 1934 Timpanogos Cave National Monument was transferred to the National Park Service. In doing so, the lands within Timpanogos Cave National Monument fell under the provisions of the Organic Act of 1916. The Organic Act requires that national park units be managed in a manner that conserves their natural and cultural resources and provides for the use and enjoyment of current and future generations. The Organic Act provides additional purpose to Timpanogos Cave National Monument, but the Proclamation of 1922 remains the dominant reservation purpose.

Location Utah County, Utah about 19 kilometers (12 miles) east of Lehi.

Elevation Elevations range from a low of 1,670 meters (5,480 feet) along the western boundary to 2,454 meters (8,050 feet) on a peak along the southern boundary.

General Description The Timpanogos Cave System is located on the south side of the steep-walled American Fork Canyon, located in the center of the Wasatch Range. The caves are accessed by a 2.4 kilometer (1.5 mile) paved trail that gains 325 vertical meters (1,065 vertical feet), placing visitors at 2,042 meters (6,700 feet). The cave system consists of three main caves, Hansen Cave, Middle Cave, and Timpanogos Cave. Each cave has its own natural entrance, but human-made tunnels connect all three. The tunnels create a one-way tour approximately 550 meters (1,800 feet) long. There is a total of 1,706 meters (5,600 feet) of passage in the cave system, with a vertical relief of 56 meters (185 feet). The caves are located an average of 46-122 meters (150-400 feet) below the surface and range in temperature between 43-49 degrees F (Horrocks and Tranel 1994). The caves formed along three minor faults and the bedding planes in the Tetro and Uncle Joe members of the Deseret Formation. They are highly decorated and are well known for vibrant colors, profusion of delicate helictites and anthodites, unique origin and rich cultural history.

American Fork Canyon's geologic history is still debated. The canyon's location marks the convergence of the Great Basin, Uinta Basin, Wasatch Range, and Uinta Mountains.

This area provides the opportunity to view significant geologic features and forces such as Utah's basin/range topography, distinctive bedding planes, a maze of faults, fault blocking, karst topography, cave formation, and tectonic plate folding. The steep walls of American Fork Canyon exemplify a V-canyon and expose many thousands of feet of sedimentary rock. These rocks include Precambrian quartzite, Cambrian quartzite, shale, and limestones, dolomites, and minor sandstones. The bulk of the known cave system is confined to the Mississippian age Deseret Limestones.

The monument's vertical relief from the visitor center to the caves not only takes visitors through geologic history, but various biological classes as well. The flora makes a transition from riparian environment to cliff-dwelling xeric plants mingled with a mesic forest at the caves. Near the caves water seeps from the rocks and provides a prime environment for mosses and ferns among sage brush and gamble oak. The fauna makes a less marked transition, but the change can be noted as well.

Plant communities include pinyon juniper; mountain brush (Gambel oak, big-toothed maple and serviceberry); white fir and Douglas fir (restricted to north-facing slopes); and riparian areas with cottonwood, alder, box elder and red-osier dogwood.

Aquatic features include waterways associated with the American Fork River and cave lakes. A very short section (0.7 mile) of the American Fork River flows through the Monument, however the channel is partially dewatered since waterflow is diverted to a hydroelectric pipeline that routes water around the Monument. The project is in the relicensing process under FERC, and negotiations are underway to find a solution to resource impacts. At least 6 cfs of water flows through the Monument at all times, and the typical steep mountain terrain produces heavy spring run-off with the snowmelt in the mountains. Brown, rainbow and cutthroat trout are present in the river.

The Timpanogos Cave system contains three main bodies of water, Hansen Cave Lake, Middle Cave Lake, and Hidden Cave Lake along with several seasonal smaller bodies of water. Surface waters within the cave appear to be generally of good quality with some impact from human activities.

Unique Features

The Timpanogos Cave system is a human-made joining of three natural caves that contain 42 types of cave formations, an unusually large variety. The cave features dramatic and rare colors and unusual combinations of delicate helictites and anthodites in quantities not found in other developed NPS-managed caves.

The Timpanogos Cave system is believed to be the result of rising thermal waters contacting the water table at the intersection of geologic bedding planes and faults; this process is unusual among NPS managed caves. The caves are heavily decorated with fantastic combinations of colors and formations created through the dissolution and subsequent deposition of minerals at varied depths, percolation rates, and infiltration methods.

The 2.4 kilometer (1.5 mile) paved trail ascends 325 meters (1,065 feet) from pre-Cambrian through late Mississippian -aged rocks, providing one of the best exposed, easiest accessed and varied geologic records in the nation.

Resource Management Concerns

Lack of Data The lack of relevant and complete data sets is TICA's greatest concern and threat. Only severely out-dated, incomplete, or non-existent data sets exist for vascular plants, mammals, birds, fish, reptiles, amphibians, and insects. This greatly limits management's ability to make informed, factual, decisions to better protect and preserve resources. There is also a complete lack of any data sets for cave biota.

Species of Special Concern Threatened or Endangered Species have not been identified, but sensitive species and species identified as sensitive species exist. A complete T&E survey has never been conducted.

Townsend's big-eared bats (*Corynothinus townsenii*) are occasional visitors in the caves and other locations.

Invasive Plants The introduction and spread of invasive exotic plant species is a growing concern. Current problems include Dalmatian toadflax (*Linaria genistifolia*), spotted knapweed (*Centaurea maculosa*), houndstounge (*Cynoglossum officinale*), and small locations of hoary cress (*Cardaria draba*).

Visitor Use Related to the invasive species concern is the concern over visitor-use impacts. While cave tours have been at near capacity for a number of years, the canyon and Monument have been receiving more visitors each year. The Monument is located within an hour's drive of 1.6 million people. The transition from a rural monument to an urban one carries concerns about possible impacts on various resources currently maintained.

ZION NATIONAL PARK (ZION)
Size 59,900 hectares (148,016 acres)

Park History and Purpose Zion National Park was originally protected by Presidential Proclamation No. 877 (36 Stat. 2489) on July 31, 1909 as Mukuntuweap National Monument. On March 18, 1918 the monument was enlarged and the name changed to Zion National Monument (40 Stat. 1760). The enlargement was effected to protect "unusual archeological, geologic and geographic interests...", and to provide opportunities for visitor enjoyment of its grandeur and scenic features. The area received National Park status by the provisions of the Act of November 19, 1919 (41 Stat. 356). Subsequent Presidential Proclamation No. 2221 of January 22, 1937, established a Zion National Monument adjacent to the then existing park. The park and monument were combined in 1956 by an act of Congress (70 Stat. 527).

The purposes for which Zion National Park was established are delineated in the Presidential Proclamation dated March 18, 1918. These purposes as interpreted in Zion National Park Statement for Management (NPS 1994b) and the General Management Plan (NPS 2001b) are

- Preserve the dynamic natural processes of canyon formation as an extraordinary example of canyon erosion.
- Preserve and protect the scenic beauty and unique geologic features: labyrinth of remarkable canyons, volcanic phenomena, fossiliferous deposits, brilliantly colored strata, and rare sedimentation.
- Preserve the archeological features that pertain to the prehistoric races of America and the ancestral Indian tribes.
- Preserve the entire area intact for the purpose of scientific research.
- Provide a variety of opportunities for visitors to learn about and enjoy the resources
- without degrading those resources.

In addition to park purposes stated above, it is also a purpose to manage the park in compliance with 1916 Organic Act, Wilderness Act, National Environmental Policy Act, National Historic Preservation Act, Native American Graves Protection and Repatriation Act, An Act to Establish Redwoods National Park, Endangered Species Act and others that may apply. In addition, the Zion National Park Resource Management Plan (NPS 1994a) supplements other park documents and legal mandates to provide guidance and direction for the long-term management of the natural and cultural resources.

Location Southwestern Utah within portions of Washington, Kane, and Iron Counties. Lying on the western extremity of the Colorado Plateau, 72 kilometers (45 miles) (by road) northeast of St. George, Utah, 523 kilometers (325 miles) south of Salt Lake City, Utah, and 254 kilometers (158 miles) northeast of Las Vegas, Nevada.

Elevation Elevations range from 1,128 meters (3,700 feet) in the southwestern corner to 2,660 meters (8,726 feet) on Horse Ranch Mountain in the northeast.
General Description ZION is characterized by high plateaus, a maze of narrow canyons, and striking rock towers and mesas. Encompassing the southern and western perimeter of

the Kolob Terrace (a southern extension of the Markagunt Plateau), the Park exhibits outstanding exposures of Permian through Cretaceous rocks. Due to the downcutting of the Virgin River, Zion Canyon provides a spectacular display of Triassic and Jurassic sediments, the most spectacular of which is the 2,000-foot thick exposure of Navajo sandstone.

The park is located at or near the common boundaries of 3 major vegetative zones, the Colorado Plateau to the north and east, Mojave desert to the south and southwest, and the basin and range to the west. This intermingling of zones combines with the rugged canyons and myriad streams and springs to produce microhabitats with a heterogeneous system of flora and fauna.

Flora Vegetative communities are varied and consist of desert scrub at the lowest elevations, pinyon-juniper woodland and mountain shrub communities at middle elevations, and coniferous forest at the highest elevations. Rock crevice communities cover large portions of the east side where opportunistic vegetation grow in slickrock cracks. Hanging gardens are unique communities that grow on vertical rock walls hosting seeps and springs. The numerous watercourses, including the North and East Forks of the Virgin River are lined with riparian vegetation consisting largely of Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus velutina*), box elder (*Acer negundo*), and seepwillow (*Baccharis* spp.). Over 890 species of vascular plants have been identified.

Fauna Over 400 birds, mammals, reptiles, amphibians, and fish occur. Amphibians are numerous along watercourses. Common amphibians are the Arizona toad (*Bufo microscaphus microscaphus*) and red-spotted toad (*Bufo puctatus*). Reptiles occur park-wide, with northern plateau lizards (*Sceloporus undulatus elongatus*), side-blotched lizards (*Uta stansburiana*) and 2 species of whiptails (*Cnemidophorus* spp.) dominating the lower elevations and sagebrush lizards (*Sceloporus graciosus*) prevailing in elevations above 5200 ft. Snakes, while present, do not seem particularly numerous. Great Basin rattlesnake (*Crotalus viridis lutosis)*, desert striped whipsnake (*Masticophis taeniatus*), and California kingsnake (*Lampropeltis getula californiae*) may be most abundant. The most common mammals include mule deer, rock squirrels, and desert cottontails. Desert bighorn sheep (*Ovis canadensis nelsoni*) have been reintroduced and appear to be healthy and increasing. Mountain lions (*Felis concolor*), while secretive and elusive, are apparent through sign which seems ubiquitous. Birds are most abundant in the riparian vegetation along the Virgin River and its tributaries. Four species of native fish populate the North and East Forks of the Virgin River, and greatly outnumber exotic species.

Aquatic Features Water resources include springs, seeps, tinajas, and the Virgin River and its tributaries. The park contains one of the last mostly free flowing river systems contributing to major canyon formation on the Colorado Plateau. Only a moderate amount of water development has occurred upstream, such as Kolob Reservoir in 1957. Flow regimes are characterized by snowmelt runoff during the April-June season and summer monsoonal thunderstorms during the July-August season. Flow regimes provide highly variable daily flows which are important to water-related resource attributes and ecosystem values.

A National Wetlands Inventory is currently in progress to map seeps and springs. These ground to surface water flows support hanging gardens and grottos that nourish unique vegetation and endemic fauna.

Unique Features and Species of Special Concern

Special Vegetation Communities The Riparian/Wetland community consists of springs, seeps, hanging gardens, and riverine systems. These areas are critical oases in an arid environment, providing productive and unique habitats for wetland plant species and a high diversity of aquatic invertebrates, amphibians, resident and migratory birds, fish, native pollinators and other organisms that create ecological balance. The Quaking Aspen (*Populus tremuloides*)/ White Fir (*Abies concolor*) community is restricted to higher elevations. These stands are becoming decadent, most likely due to past fire suppression. Little is known about biodiversity within these stands. The many Isolated Mesa Tops are believed to have undisturbed populations of relict flora, offering rare opportunities for scientific research of relatively pristine environments.

Rare and Threatened Plants ZION contains one Federally endangered plant species, the Shivwits milkvetch (*Astragalus erectimus* var. *ampullariodes*). This species was recently listed because of its extremely limited range, growing only on a specific geologic formation—the Chinle. At least 20 other rare plant species occur, consisting of endemics and disjunct populations. Most rare plants are psammophytes (i.e., plants specifically adapted to grow in sand, sandy depressions, and sandstone crevices). Distribution and abundance inventories rare plants are needed, especially in remote areas.

Animals Federally listed animal species include 3 listed birds, and one listed reptile. The Threatened Mexican spotted owls (*Strix occidentalis lucida*) inhabits narrow canyon habitats. In addition, southwest willow flycatcher (*Empidonax traillii extimus*) has been found during summer months in patches of dense riparian vegetation. In winter, bald eagles (*Haliaeetus leucocephalus*) perch in towering cottonwoods along watercourses. A small population of desert tortoise (*Gopherus agassizii*) exists at one low elevation site.

Among sensitive species is the recently delisted peregrine falcon (*Falco peregrinus*) which thrives on and around the steep canyon walls where it nests. The park also hosts the Virgin spinedace (*Lepidomeda mollispinis mollispinis*), a small fish which is narrowly kept from threatened status through a habitat conservation agreement amongst numerous land management agencies. Another sensitive species, the endemic Zion snail (*Physa zionis*) inhabits unique hanging garden habitats. The northern leopard frog (*Rana pipiens*) is a rare resident which seems to be disappearing regionwide due to unknown causes.

Resource Management Concerns

Recreational Use Visitation has been on the increase throughout the 20th century. Park visitors numbered 3,692 in 1920. In 1996, visitation reached 2.5 million per year. As more visitors arrived, impacts became noticeable. Fragile ecosystems around riparian areas are being trampled and eroded while human waste and toilet paper accumulate around camping areas threatening the quality of backcountry water sources. Other resource impacts caused by increasing visitor use include soil erosion, loss of critical microbiotic soils, desertification, vegetation trampling and denudation, root exposure, and resultant degradation of wildlife habitat and ecological function.

As part of the Visitor Experience Resource Protection (VERP) process some soil comparisons have been made between sites impacted by recreationists and sites not impacted. With the advent of the Zion Transportation System it is thought that visitor use patterns may change. Site monitoring has been established in several locations to assess impacts of changes on vegetation and soils.

Land Use Impacts Land development continues around the perimeter. While a water-rights agreement has protected instream flows in the North and East Forks of the Virgin River, individual springs and seeps may still be impacted by the use of ground water by development around the park. Water quality may be impacted by cattle grazing in areas upstream. While the park actively controls noxious week species, seed sources from outside are able to establish by floating downstream or arriving on wind currents from infested areas. Cattle grazing continues around the park and within inholdings. Trespass cattle damage is an ongoing problem as is degradation of habitat due to past grazing within the park.

Invasive Exotic Plant Species Over 100 non-native plant species occur. Nine are of top management concern for control and eradication. Tamarisk (*Tamarix ramossisima*) and Russian olive (*Elaeagnus angustifolia*) are primary invasive species along riparian areas. Scotch thistle (*Onopordum acanthium*) and wooly mullein (*Verbascum thapsus*) are common along trails and disturbed areas in the front and backcountry. Around the developed area, showy nightshade (*Solanum elaeagnifolium*), Russian thistle (*Salsola pestifer*), tree-of-heaven (*Ailanthus altissima*) and Johnson grass (*Sorghum halapense*) are abundant. Other problem species include numerous exotic grasses, yellow sweet clover (*Melilotus officinalis*), and exotic thistles. Control actions and some inventory are in place for high priority locations and problem species. Extensive inventories for invasive non-native weeds are needed to aid prioritization and control.

Degradation of Riparian Areas To a large degree native riparian vegetation is not regenerating within Zion Canyon. Flood prevention measures have been successful in preventing widespread flooding which provides the moist, bare substrate necessary for riparian plant regeneration. Control of the river course, provided by gabions, has prevented natural meanders and have promoted the deepening river channel and drying of the streamside terraces. The resultant vegetation consists largely of an overstory of mature cottonwoods, boxelder, and velvet ash, many of which are dead and dying. Little or no native midstory vegetation exists and in certain areas, only herbaceous cover is in place. Regenerating woody vegetation is mostly non-native species, specifically tamarisk, which exudes salt and effectively prevents natives from establishment. This in turn causes loss or degradation of wildlife habitat.

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